SOCIO-ECONOMIC ANALYSIS

NON-CONFIDENTIAL REPORT

Legal name of applicants: *Gerhardi Kunststofftechnik GmbH*

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BIA Kunststoff- und Galvanotechnik GmbH & Co. KG

Heinze Gruppe GmbH

Bolta Werke GmbH

Boryszew Oberflächentechnik Deutschland GmbH

WAFA Germany GmbH

Aludec Galvanic s.a.

C+C Krug GmbH

Fischer GmbH & Co. surface technologies KG

SAXONIA Galvanik GmbH

Karl Simon GmbH & Co. KG

Submitted by: *Gerhardi Kunststofftechnik GmbH*

Substance: *Chromium trioxide, EC No: 215-607-8, CAS No: 1333-82-0*

Use title: *Plating on Plastics for Automotive Applications (PoPAA).*

Use number: *1*

CONTENTS

DECLARATION

We, Gerhardi Kunststofftechnik GmbH, C. Hübner GmbH, BIA Kunststoff- und Galvanotechnik GmbH & Co. KG, Heinze Gruppe GmbH, Bolta Werke GmbH, Boryszew Oberflächentechnik Deutschland GmbH, WAFA Germany GmbH, Aludec Galvanic s.a., C+C Krug GmbH, Fischer GmbH & Co. surface technologies KG, SAXONIA Galvanik GmbH, and Karl Simon GmbH & Co. KG request that the information blanked out in the 'public version' of the socio-economic analysis is not disclosed. We hereby declare that, to the best of our knowledge as of today (February 22nd, 2016) the information is not publicly available, and in accordance with the due measures of protection that we have implemented, a member of the public should not be able to obtain access to this information without our consent or that of the third party whose commercial interests are at stake.

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LIST OF ABBREVIATIONS

ACEA	European Automobile Manufacturer's Association
AfA	Application for Authorisation
AoA	Analysis of Alternatives
BW	Body Weight
CBA	Cost-Benefit Analysis
Cr(VI)	Hexavalent Chromium
Cr(III)	Trivalent Chromium
CSR	Chemical Safety Report
CTAC	Chromium Trioxide REACH Authorisation Consortium
DEHP	Diethylhexyl phthalate
ECHA	European Chemicals Agency
EEA	European Economic Area
ELR	Excess Lifetime Risk
ETESS	Expert Team providing Scientific Support for ECHA
EU	European Union
EUROSTAT	Statistical Office of the European Communities
FGK	Fachverband Galvanisierte Kunststoffe
GDP	Gross Domestic Product
IARC	International Agency for Research on Cancer
MVE	Man via the Environment
NewExt	New Elements for the Assessment of External Costs from Energy Technologies
NPV	Net Present Value
NUS	Non-Use Scenario
OECD	Organisation for Economic Cooperation and Development

OEM	Original Equipment Manufacturer
PEC	Predicted Environmental Concentration
PoPAA	Plating on Plastics for Automotive Applications
PVC	Polyvinyl chloride
RAC	Risk Assessment Committee
SEA	Socio-Economic Analysis
SEAC	Socio-Economic Analysis Committee
SMEs	Small and Medium Enterprises
SVHC	Substance of Very High Concern
UBA	Umweltbundesamt (German Federal Environmental Agency)
VSL	Value of Statistical Life
WCS	Worst Case Scenario
WTP	Willingness to Pay

PREAMBLE

The applicants are submitting this joint application for Plating on Plastics for Automotive Applications (PoPAA) although the use is already covered by the CTAC AfA under Use 3. Furthermore, most of the applicants are members of the CTAC consortium and contributed significantly to the development of the documents. However, the review period applied for Use 3 in the CTAC application is a compromise between the different industries sectors. Therefore, the Fachverband Galvanisierte Kunststoffe e.V. (FGK), representing most of the German PoP companies, already emphasised in the CTAC public consultation that a review period of seven years is much too short and that a review period of a minimum of twelve years would be needed because of the unique situation in the automotive sector[1].

The applicant's situation is unique because of the following reason:

1. The Automotive customers' demand extremely strict requirements on the quality and reproducibility of the processes and products:
2. The need for planning security due to long-term demands on processes caused by the long development and life cycles of the vehicles (comparable to the aerospace industry):
3. High level of automatic production with best protection of environment and personnel.

In total, the applicants' market share for chrome plated plastic parts used in automotive manufacturing is estimated to be 80-90% in Germany and between 35% and > 50% in Europe. These figures demonstrate the strategic importance of the applicants' production activities for the European automotive industry.

If the applicants cannot assure security of supply to the OEMs over the period of design, prototype production, serial production and repair (in average >22 years), they will lose their market in the EU as the OEMs will source chrome plated plastic parts from non-EU markets. Already today non-EU suppliers use this locational advantage to take away parts of business with lower quality demands from the suppliers located in the EU.

[1] Fachverband Galvanisierte Kunststoffe (2015). Comment number 636 on review period in the public consultation of the AfA for chromium trioxide in functional chrome plating with decorative character (Consultation Number 0032-03). http://echa.europa.eu/documents/10162/18074545/a4a_comment_636_1_attachment_en.pdf (last access Feb. 2016).

1. SUMMARY OF SOCIO-ECONOMIC ANALYSIS

The socio-economic analysis (SEA) has been performed for the use of chromium trioxide for Plating on Plastics for Automotive Applications (PoPAA).

For the purpose of this SEA, a time frame of **12 years** after the sunset date (review period) is assessed.

The outcomes of this SEA are briefly summarised in the following.

Monetised residual risks to human health and the environment of a granted authorisation based on the ECHA guidance will be lower than:

- EUR 9.6 million (including impacts to workers at the sites of the applicants and to the public 'man via environment')

For the investigation, a methodology has been used that is described in ECHA Guidance on the preparation of socio-economic analysis as part of an application for authorisation (1) and the reference dose response relationship for carcinogenicity of hexavalent chromium substances agreed on at the 22nd meeting of the Committee for Risk Assessment (RAC) in September 2012 (2). However, the applicants and companies in the supply chain that may directly or indirectly rely on the application for authorisation (AfA) do not and should not by preparing this quantified cost-benefit analysis or otherwise be construed to endorse, support, or otherwise accept the approach to the monetisation of health impacts. Data have been collected directly at the applicants' sites. Exposure data for the assessment of health impacts were taken from the corresponding chemical safety report (CSR). They have been tackled in the methodology in a way that the risks to human health and the environment are in no way underestimated.

This justifies the statement 'lower than EUR 9.6 million'. Uncertainties and the influence of different parameters on the results are documented in a sensitivity analysis.

Socio-economic impacts of a non-granted authorisation:

The outcomes of the respective analysis of alternatives (AoA) were considered when defining the non-use scenarios (NUS). As explained in the AoA, the applicants are bound to strict quality requirements by their customers and qualification schemes, which require the use of chromium trioxide. Due to these constraints and as explained in detail in Section 4, it was not possible to provide one single NUS. The results of the AoA demonstrate that depending on acceptance by customers, different scenarios may be possible and therefore three scenarios have been analysed. It is important to remember that the NUS 1 (substitution by Chromium(III)) and 2 (use of PVD technologies) consider a switch to non-feasible alternatives, which means that these scenarios are not realistic today. Nevertheless, these scenarios provide the rapporteurs with information regarding which efforts the applicants would have to accept and which impacts would occur in case chromium trioxide would be replaced by the discussed non-feasible alternatives and therefore shall support the opinion making process. Based on the fact that the conditions for substitution of chromium trioxide by the non-feasible alternatives analysed in NUS 1 and 2 are not fulfilled today and no information is available when the technical requirements and acceptance by the market (OEMs) will be given, the most likely NUS at this time is NUS 3 (the relocation of sites to non-EEA countries). As a best-case scenario, it has been assumed that all applicants will relocate to non-EEA countries although it is obvious that some of the applicants will not be able to relocate due to missing financial capacities to do the necessary investments and would therefore shut down their activities. It has to be taken into account that the applicants are faced with growing competition from non-EEA countries and in several cases, it can be expected that non-EEA competitors will take over market shares and customers from applicants as increasing manufacturing capacities at existing non-EEA sites is by far less time consuming compared to complete relocation. However, against the background that it is impossible to anticipate in detail the reaction of OEMs, customers and non-EEA competitors, potential shut down of sites and resulting consequences for European society have not been monetised. Instead, relocation costs have been estimated and presented, which was possible with limited uncertainties.

Assuming that technical limitations for implementation of Cr(III) would be solved by the sunset-date and assuming that OEMs would accept products manufactured with Cr(III), the applicants consider implementation of Cr(III) as the most favourable NUS providing that a Cr(VI)-free etching exists.

Non-use scenario 1: Substitution by non-feasible alternative Cr(III)

- Impacts related to investment costs amounting to at least EUR **Blank 1** (see Section 7.2.1).
- Impacts related to loss of added value due to temporary shut-down of production amounting to at least EUR **Blank 1** (see Section 7.2.3).
- Impacts related to costs for re-qualification amounting to at least EUR **Blank 1** (see Section 7.2.2).
- Impacts related to increased production costs and higher reject rates amounting to at least EUR **Blank 1** (see Section 7.2.4).
- Impacts occurring in the supply chain and at OEMs due to temporary interruption of supply amounting to at least EUR 756.0 million (see Section 7.2.5).
- Unemployment costs amounting to at least EUR 36.7 million (see Section 7.2.6).
- **Total socio-economic impacts: > EUR Blank 1**

Non-use scenario 2: Substitution by non-feasible alternative PVD

- Impacts related to investment costs amounting to at least EUR **Blank 1** (see Section 7.3.1).
- Impacts related to loss of added value due to temporary shut-down of production amounting to at least EUR **Blank 1** (see Section 7.3.3).

- Impacts related to costs for re-qualification amounting to at least EUR Blank 1 (see Section 7.3.2).
- Impacts related to increased production costs and higher reject rates amounting to at least EUR Blank 1 (see Section 7.3.4).
- Impacts occurring in the supply chain and at OEMs due to temporary interruption of supply amounting to at least EUR 756.0 million (see Section 7.3.5)
- Unemployment costs amounting to at least EUR 36.7 million (see Section 7.2.6).
- **Total socio-economic impacts: > EUR Blank 1**

Non-use scenario 3: Relocation to non-EEA territory

- Impacts related to relocation costs amounting to at least EUR Blank 1 (see Section 7.4.1).
- Impacts related to loss of added value due to temporary shut-down of production amounting to at least EUR Blank 1 (see Section 7.4.3).
- Impacts related to costs for re-qualification amounting to at least EUR Blank 1 (see Section 7.4.2).
- Impacts occurring in the supply chain and at OEMs due to temporary interruption of supply amounting to at least EUR 756.0 million (see Section 7.4.4).
- Unemployment costs amounting to at least EUR 37.6 million (see Section 7.2.6).
- **Total socio-economic impacts: > EUR Blank 1**

Also for the calculation of socio-economic impacts, intensive data collection was done by all applicants for every site individually. The data for economic impacts are based on clear causal chains for the case of a non-granted authorisation and were confirmed by single applicants. Uncertainties and potential variations are investigated in the sensitivity analysis that comes to the conclusion that the result is stable and defines an underestimation of real impacts to be expected. Economic impacts were calculated on the basis of information provided by applicants and publicly available information regarding the automotive sector.

The benefits of continued use for all NUS clearly outweigh the risks to human health and the environment in monetary terms (see summary table of the impact assessment in Section 8.1). By the modelling parameters chosen, health impacts are most certainly vastly overestimated and socio-economic impacts are intentionally underestimated.

Minimum impacts calculated for the ‘cheapest NUS’ outweigh health impacts by a factor of 140. It has to be taken into account that maximum health impacts calculated for continued use of chromium trioxide per site and year amount to EUR 36,410.

Apart from the outcomes of the quantitative impact assessment conducted in this SEA, the following factors are relevant for the assessment of the review period, and these are further evidenced in the SEA report:

- The chromium metallic layer deposited in a part or article after PoPAA is completely free of Cr(VI) (see Section 3).
- Complex adaptation processes and procedures, reflecting industry-specific requirements and regulations (see Section 3.4).
- The very large number of parts manufactured by the applicants for the automotive industry in combination with high quality requirements/standards and the complex supply chains involved result in long transition periods for implementation of potential alternatives (see Sections 3.1 and 3.3).
- The economic and strategic importance of the automotive sector within the European Economic Area (see Section 3.4).
- Long lifecycles of cars and consequently automotive components that are treated with chromium trioxide (see Section 5).
- Wider economic impacts in case of relocation to non-EEA countries that are not quantified here, inter alia (see Section 7.4.7):
    - further companies in the supply chain between the applicants and the OEMs might consequently also relocate to non-EEA countries;
    - negative impacts on trade and distortion of competition;
    - negative impacts on national budgets due to loss of taxes paid;
    - know-how loss in the supply chain;
    - relocation of R&D activities;
    - negative impacts on the quality and safety of various components;
    - less good occupational health & safety conditions for the workforce (compared to high European health & safety standards).

Considering all factors elaborated in this SEA, a review period of not less than **12 years** is clearly justified.

2. AIM AND SCOPE OF SEA

2.1. Aim

Chromium trioxide is classified under REACH as a substance of very high concern (SVHC) (according to Article 57(a) of Regulation (EC) No 1907/2006 (REACH) (3). It was included in the list of substances subject to authorisation (Annex XIV) in the course of the third recommendation of ECHA for the inclusion of substances in Annex XIV from 20th December 2011. Furthermore, chromium trioxide is categorised as a non-threshold substance and therefore the so-called socio-economic analysis (SEA) route is foreseen under REACH (4).

Gerhardi Kunststofftechnik GmbH, C. Hübner GmbH, BIA Kunststoff- und Galvanotechnik GmbH & Co. KG, Heinze Gruppe GmbH, Bolta Werke GmbH, Boryszew Oberflächentechnik Deutschland GmbH, WAFA Germany GmbH, Aludec Galvanic s.a., C+C Krug GmbH, Fischer GmbH & Co. surface technologies KG, SAXONIA Galvanik GmbH, and Karl Simon GmbH & Co. KG apply for authorisation to continue use of chromium trioxide in PoPAA after the sunset date in September 2017. It is intended that this application covers the downstream use of chromic acid in accordance with ECHA Q&A 805.

This socio-economic analysis (SEA) forms part of the application for authorisation (AfA) for the use of chromium trioxide in PoPAA. Other documents prepared as part of the AfA include a chemical safety report (CSR) and an analysis of alternatives (AoA). These documents are referenced here to provide context for the SEA. The AoA demonstrates that there are no available (qualified and industrialised) substitutes for PoPAA until and beyond the sunset date (see corresponding AoA document). The aim of this SEA is to robustly demonstrate that the socio-economic benefits associated with the continued use of chromium trioxide in PoPAA outweigh the remaining risks to human health and the environment associated with prevailing use conditions.

2.2. Scope

PoPAA in this case is defined as the electrochemical treatment of plastic or composite surfaces to deposit metallic chromium in the production of parts for automotive applications to achieve a high level of corrosion protection, to enhance durability and to improve surface appearance. It is important to recognise that the final chromium coating does not contain chromium trioxide or any other Cr(VI) compounds, such that it is safe to use. PoPAA includes the use of chromium trioxide in one or more series of pre-treatments. Further technical details, requirements and process descriptions can be found in the corresponding AoA.

Further background to the automotive industry and applications of parts manufactured by the applicants is provided in the following sections of this document. The European automotive industry has evolved over many decades and is characterised by a broad, integrated, complex and multi-tiered supply chain.

Recognising the need to secure the use of chromium trioxide to ensure continued availability of critical components beyond the sunset date, the severe consequences associated with failing to do so, and the challenges associated working with a mature and complex supply chain, several companies manufacturing automotive parts organised a group to facilitate this joint application for authorisation of chromium trioxide. The scope of analysis concentrates geographically on the territory of the European Economic Area (EEA), which is comprised of the European Union and the states of Iceland, Liechtenstein and Norway[2]. The applicants' 22 sites covered by this SEA are located in Germany, Spain, Czech Republic and Slovakia.

Impacts considered in this SEA include (1) health impacts related to the continued use of chromium trioxide in PoPAA, and (2) socio-economic impacts linked to a decision not to authorise the continued use of chromium trioxide in PoPAA. For the purpose of this SEA, a review period of 12 years is assessed. The review period presents the outcome of the AoA coinciding with the estimates by the industry of the schedule required to industrialise alternatives to chromium trioxide for PoPAA. Since the sunset date for chromium trioxide is in September 2017, the period of time covered by the SEA runs from 2018 to 2030 (taking 2017 as a base year for calculations). A sensitivity assessment has been included to demonstrate that there is a robust case for the review period applied for.

2 Means the 'customs' territory of the Community as defined in the REACH Guidance for the Navigator. The customs territory of the Community comprises the territory of: Austria; Belgium, Bulgaria, Croatia, Cyprus, The Czech Republic, Denmark (except the Faroe Islands and Greenland), Germany (except the Island of Helgoland and the territory of Büsingen), Estonia, Finland (including the Aland Islands), France (except New Caledonia, Mayotte, Saint-Pierre and Miquelon, Wallis and Futuna Islands, French Polynesia and French Southern and Antarctic Territories), Greece, Hungary, Ireland, Italy (except the municipalities of Livigno and Campione d'Italia and the national waters of Lake Lugano which are between the bank and the political frontier of the area between Ponte Tresa and Porto Ceresio), Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Poland, Portugal, Romania, Slovenia, The Slovak Republic, Spain (except Ceuta and Melilla), Sweden, The United Kingdom of Great Britain (including Northern Ireland and the Channel Islands and the Isle of Man). The customs territory of the Community includes the territorial waters, the inland maritime waters and the airspace of the Member States and the territory of the Principality of Monaco, except for the territorial waters, the inland maritime waters and the airspace of those territories which are not part of the customs territory of the Community as listed above.

3. DEFINITION OF THE APPLIED FOR USE SCENARIO

PoPAA is applied in the production process of a large variety of components for the automotive interior and exterior. In all applications, chromium trioxide is critical to the plating process to achieve a high level of corrosion protection, to enhance durability and to achieve a bright and decorative coating with a slightly bluish colour. The high aesthetic requirements are achieved by the special surface properties provided by chromium. Apart from the appearance, important functional characteristics conferred by the use of chromium trioxide in the plating process are corrosion and chemical / cleaning agent resistance, wear and abrasion resistance, good adhesion on different kind of substrates and underlying coatings, haptic (metallic surface feel), hygienic (easy cleaning), long lifetime, non-toxic deposit and non-allergenic. Additionally, as chrome coated products from different companies are often installed together (for example automotive interior), the colour stability / colour match of these products is of special importance.

From a technical point of view, PoPAA is usually applied in thin deposits (submicron thickness) with the goal of obtaining a very level, durable, bright and shiny surface. Plastic substrates have to be pre-treated adequately by etching prior to subsequent process steps. For more details, please refer to the corresponding AoA documents.

Today, the safe handling of chromium trioxide and the related processes are regulated through several laws and regulations such as:

- Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (recast).
- Regulation EC/1272/2008 (of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures.
- Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
- Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment.
- Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances (Seveso-II-Directive).
- Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC Text with EEA relevance (Seveso-III-Directive).

- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

Therefore, it can be clearly stated that the application of chromium trioxide in PoPAA happens under controlled and safe conditions. Furthermore, the chromium metallic layer deposited in a **part or article after PoPAA is completely free of Cr(VI)**.

3.1. Information on applicants

The applicants Gerhardi Kunststofftechnik GmbH, C. Hübner GmbH, BIA Kunststoff- und Galvanotechnik GmbH & Co. KG, Heinze Gruppe GmbH, Bolta Werke GmbH, Boryszew Oberflächentechnik Deutschland GmbH, WAFA Germany GmbH, Aludec Galvanic s.a., C+C Krug GmbH, Fischer GmbH & Co. surface technologies KG, SAXONIA Galvanik GmbH, and Karl Simon GmbH & Co. KG operate a total of 22 sites in different European countries (e.g. Germany, Spain, Czech Republic and Slovakia). At all these sites PoPAA based on chromium trioxide is used to produce plastic parts for the automotive industry. In most of the cases, plastic parts to be surface treated are manufactured on site, but there are also sites where parts manufactured at other sites are used for plating.

The number of different types of plastic parts produced for the automotive industry per site ranges between approximately 100 and > 3,000. In total, the applicants produce more than 10,000 different types of articles. The overall number of parts produced for the automotive industry per year at the applicants' sites sums up to more than **Blank 1**. The number of parts of a specific type produced per year at single sites can range from 100 (spare parts) to over 1 million (serial car production). These figures demonstrate the strategic importance of the applicants' production activities for the European automotive industry and show that significant efforts would be required for re-qualification if chromium trioxide would be no longer available for the applicants. Furthermore, it is clear that the production capacity, which would be lost in case the applicants would have to stop their production in Europe cannot be replaced by non-EEA competitors in the short term. Consequently, at least a temporary supply chain interruption with severe impacts for European automotive manufacturers has to be expected in case of a non-granted authorisation.

The applicants deliver the major share of their products to European OEMs and automotive suppliers. Due to the complexity of the supply chain, it is difficult to estimate market shares but in total, the applicants' market share for chrome plated plastic parts used in automotive manufacture is estimated to be 80-90% in Germany and between 35% and > 50% in Europe. Although a minor share of parts is also exported to non-EEA countries, no detailed information on the worldwide market share is available.

A strong increase of the demand of chrome-plated plastic components especially in the automotive sector is expected in the near future. This can be explained, on the one hand, by a general growth of the automotive market particularly in Asian countries and, on the other hand, by the fact that these elements lead to an enormous reduction of weight and thus to a major saving of fuel costs when integrated into the vehicle. The applicants expect that their business will steadily grow in future with annual growth rates of approximately 5 to 10% due to the increasing demand for chrome plated parts not only in the premium car segment. The demand for chrome plated plastic parts to be used in cars has been steadily increasing because of the rising demand for European cars and the increasing use of these parts, not only in the luxury car segment, but also in the other classes. Today, chrome plated plastic parts are commonly used by OEMs in cars to meet the demands on design and haptic of the surfaces, to increase handling and security at night by using lit chrome-plated components and to reduce the overall weight of the vehicles (to finally achieve fuel savings and better emission values).

The present European market of electroplated plastic components based on Cr(VI) is highly competitive, since low-wage countries, such as China and India, are entering the market and profit more and more from the advantage of location concerning automotive manufacturers producing outside the EEA. Currently, the European market situation in this sector is still stable due to a high quality of the components, the advantage of experience, long-term contracts and new orders. However, additional costs due to a complete process conversion, which cannot be transferred to end-customers would lead in many cases to a shutdown of the production plants. This assumption is further reinforced by the fact that a low margin is typical for this sector. Since clients still demand and appreciate the high-quality impression of chrome-plated surfaces (optical and haptic aspects, corrosion resistance, longevity) a purchase from non-EEA countries is a logical consequence leading to a complete shift of the market.

Overall, the applicants employ approximately 5,800 persons with different educational background. It should be mentioned that besides around 290 persons with academic background, more than 1,700 high skilled persons and around 3,800 low skilled persons work at the applicants' sites. This demonstrates the importance of the applicants' sites for the local labour market and is further underlined by annual salary costs of EUR **Blank 1** paid by the applicants at their 22 sites.

In 2014 the applicants' turnover reached EUR **Blank 1** with EUR **Blank 1** directly correlated to PoPAA based on Cr(VI) electroplating. Production costs excluding salary costs (e.g. raw material, energy, transportation, external services) spent by the applicants amount to EUR **Blank 1** with **Blank 1** directly correlated with chromium trioxide use.

3.2. Plating process

As explained in detail in the AoA, when industrialising a plating system, the whole system must be considered. As a consequence, there is a link between substances, process steps and products to ensure complete compatibilities of each element of a complex system and the ultimate characteristics or functionalities which each component, sub-system or system must meet.

In the process of PoPAA, the base material is generally plated with layers of copper and nickel followed by a relatively thin layer of chromium to achieve the required finishing properties, i.e. a bright surface with wear and tarnish resistance. The chromium plating process consists of a series of operations. Figure 1 illustrates the process flow. Further details of the process can be found in the corresponding AoA.

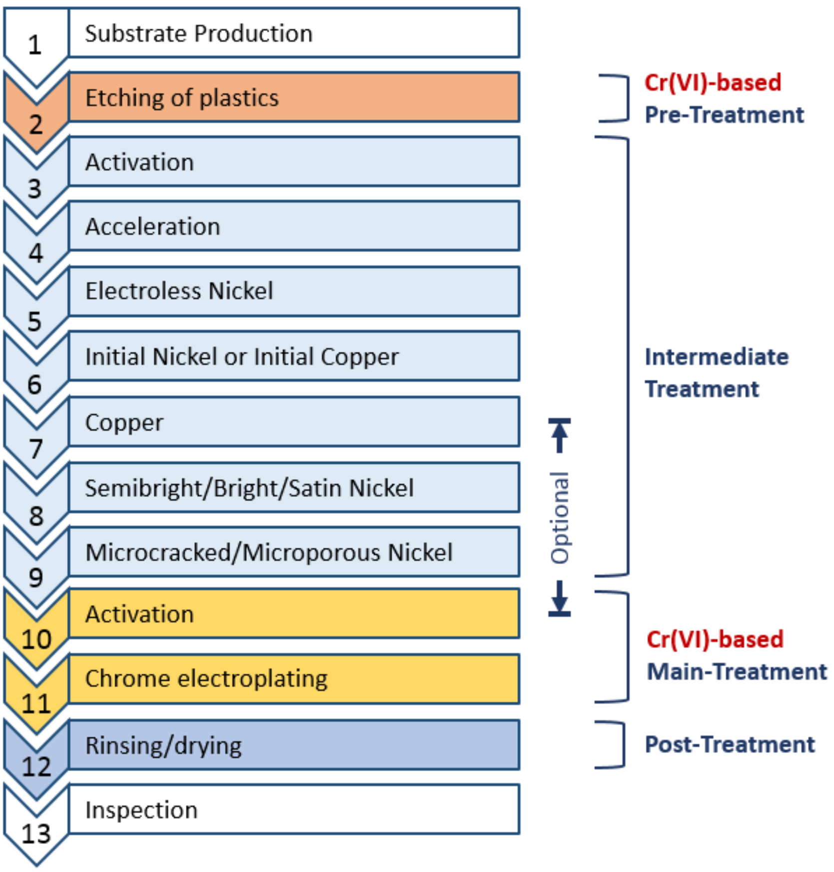

Figure 1: Flow chart for the plating process. Only in step 2 and step 11 Cr(VI) is used.

The applicants continuously invest in improvement of their electroplating systems and manufacturing processes. Annual investments per site range from EUR **Blank 1** to **Blank 1**. Significant investments in RMMs like efficient ventilation and separation of electroplating baths from regular workplaces have been done in the last years.

Furthermore, new manufacturing sites and new electroplating lines have been constructed and put into operation to increase production capacities as a response to growing demand of the applicants' products by the market.

3.3. Supply chain

The applicants supply primarily the automotive sector and only the production of automotive parts is covered by this AfA. Figure 2 presents a generalised supply chain of chromium trioxide used in the PoPAA by the applicants (FGK members).

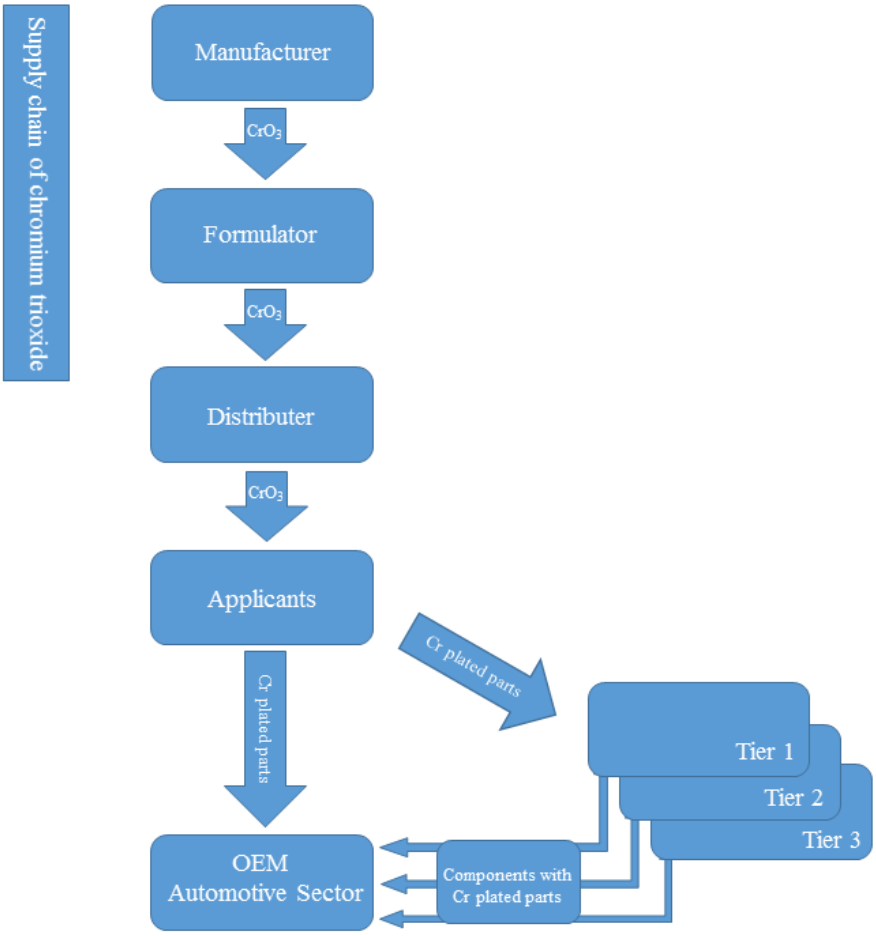

Figure 2: Generalised supply chain of chromium trioxide used in the PoPAA by the applicants.

Chromium trioxide is manufactured outside the EEA, imported, and partly distributed to formulators that produce mixtures containing chromium trioxide. These mixtures are then sold either directly or via distributors to the applicants that do PoPAA in-house as part of the production line. Some chromium trioxide is not formulated and goes directly from importers (via distributors) to the plating shops.

It is important to mention that the applicants or its customers or its suppliers produce the components (plastic parts) to be coated in-house or within its region. This also includes design and production of tools and other production equipment. The chrome plated components are then either sold directly to OEMs (automotive manufacturers) or to 1st, 2nd or 3rd tier companies, who assemble the plated part to a component, such as a dashboard, which then is delivered to the OEM. It has to be highlighted in this context that the applicants are part of a complex supply chain. Thus, a non-authorisation would not only affect the applicants, but rather lead to wide economic consequences concerning production and workplaces in other sectors, such as tire and engine manufacturing.

3.4. Applications and end-uses of chrome plated parts

The applicants produce interior and exterior parts for motor vehicles (e.g. trucks, cars, motorcycles) such as grilles, handle, logo and emblems, covers and shielding, console decorations, airbag badge, decorative strips, rings, knobs, rotary elements etc. Overall, a single passenger car can easily contain up to 150 chrome plated interior and exterior parts.

The EU is among the world's largest producers of motor vehicles. The automotive industry is therefore central to Europe's prosperity[3]. There are 6.6 million vehicles exported to almost every country around the world (34% to Asia and Oceania, 26.8% to North America, 25.1% to EFTA and Eastern Europe, 6.8% to Africa, 4.8% to the Middle East and 2.4% to South America and the Caribbean).

According to the European Automobile Manufacturers Association (ACEA) (5) 17.2 million motor vehicles (thereof 15.0 million passenger cars) were manufactured in the EU in 2014, which is 19% of the 90.6 million motor vehicles (thereof 72.3 million passenger cars) produced worldwide. Concerning the manufacturing of motor vehicles in Europe 2.3 million people (7.6% of EU employment in manufacturing) were employed (2012). Overall, when additionally regarding the domains service and construction, 12.1 million people (5.6% of total EU employment) worked in this sector (including activities besides from manufacturing, such as automobile use, maintenance and repair as well as activities such as transport by road and construction of roads that may not be impacted by a decision not to authorise, assuming chrome plated parts can be readily supplied from non-EEA companies). Furthermore, a trade surplus of EUR 95.1 billion was generated by the European automobile industry in 2014. In addition, the automotive sector represents the EU's largest investor in R&D investing EUR 41.5 billion in 2013. In total, the European Patent Office granted more than 6,000 patents dealing with the automotive sector in 2014.

In addition to being one of the most important industries in the EEA, the automotive sector is also one of the most technically complex. The high degree of technical sophistication within the industry has also characterised its supply chain structure, which has formed over the decades as companies

3 http://ec.europa.eu/growth/sectors/automotive/index_en.htm [Cited: 16 February 2015].

have focussed on their core competencies to preserve high efficiency. Around 75% of a vehicle's original equipment, components and technology are sourced from automotive suppliers (6).

Figure 3 shows a simplified structure of the automotive supply chain. In reality, there are around seven tiers of suppliers within the value added chain.

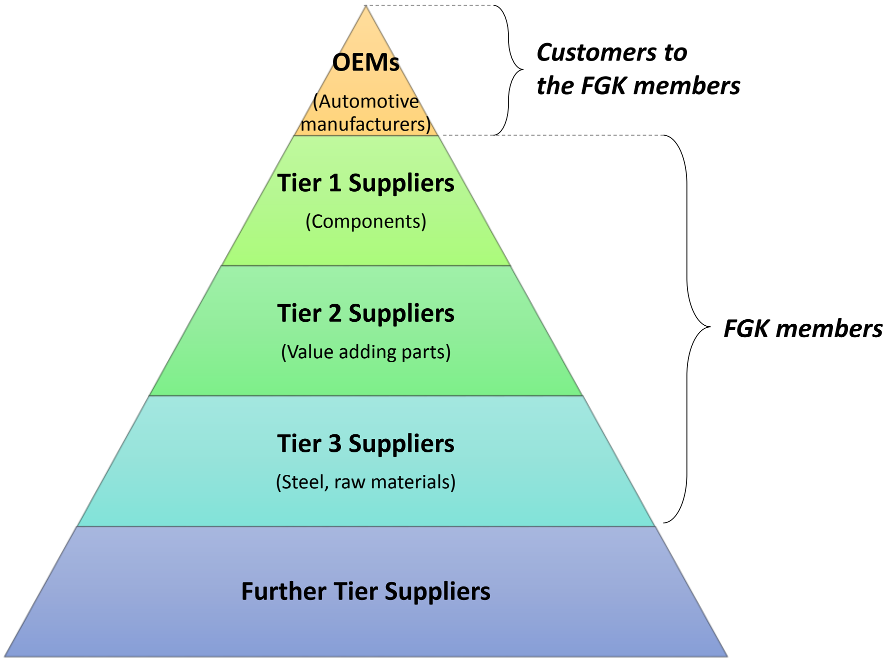

Figure 3: Basic structure of the automotive supply chain and role of applicants (FGK members) and OEMs within it (adapted from Heneric et al. 2005).

The complexity of the overall supply chain is demonstrated in Figure 4. When looking at the supply chain structure, it is obvious that OEMs receive chrome-plated parts from different suppliers and also article assemblers are supplied by different companies performing PoPAA. The assembly of vehicles is performed in a complex network of manufacturing plants, which form a multi-tier system producing different parts, such as exterior sheets or steering wheels. With an average of 1,500 to 4,500 OEM suppliers, which have an average of 500 to 1,500 suppliers themselves, tracking down chromium trioxide dependent parts is a time-consuming and complicated task and it is impossible for the applicants to foresee reactions of all companies involved in this complex supply chain.

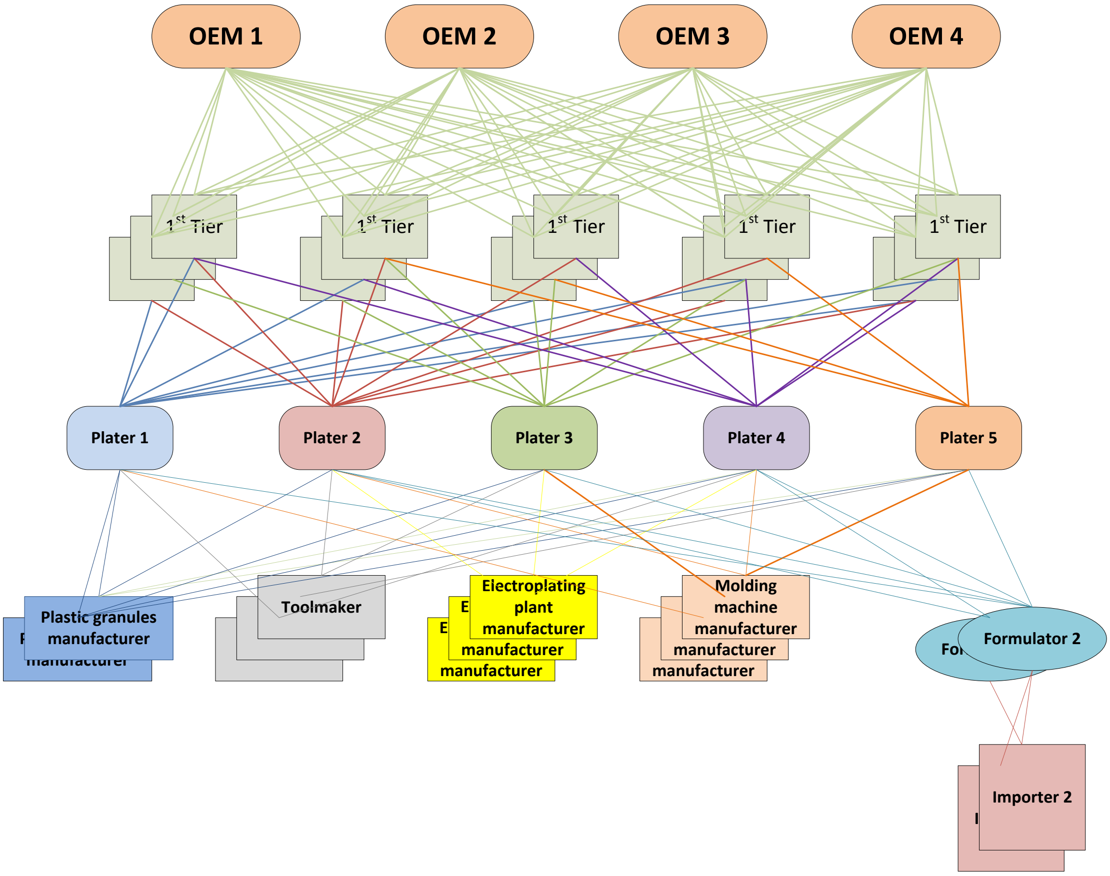

Figure 4: Illustration of supply chain complexity.

Many suppliers of the car manufacturers are already involved in the design and conception of the parts (which starts usually more than 5-7 years before production start). These companies provide not only chrome plating on plastic parts, they also produce the parts (by injection moulding) and provide the final assembly of components. The plating process itself is only one important step in the overall value chain, the associated processes demand a much higher labour force.

As already mentioned in Section 3.1, the demand for chrome plated plastic parts to be used in cars has been steadily increasing because of the rising demand for European cars and the increasing use of these parts, not only in the luxury car segment, but also in the other classes. Parts can be found in various matt designs with specific colours for each OEM or bright chrome in the interior as well as in the exterior of cars. Especially the fast-growing export markets (e.g. Asia) are asking for this premium appearance of European cars.

The interior of a car contains up to 80 different chrome plated parts (one third from that are multicomponent parts), which are delivered to the car manufacturer by five to seven different supply chains. All parts must show compatibility in terms of quality and colour. Besides that, the parts have to withstand temperature fluctuations between -40 °C to +80 °C[4] (heat resistance up to 110 °C according to OEM regulations) as well as exterior conditions like mud, dust and salt in winter times. All previously stated requirements and endurance of these parts over many years can only be achieved by the use of chromium trioxide in the PoPAA process.

It is of upmost importance to understand that parts OEMs use to manufacture an automotive coming from different suppliers must provide identical properties. Regarding plastic parts with chrome surfaces, this means that these parts even if they are produced by different manufacturers, they must show identical properties regarding colour, corrosion resistance and haptic properties. An unacceptable situation for OEMs for example, is where chrome plated parts supplied by different providers change in colour over the lifetime of the part in different ways or times. The same is true for spare parts, which must show the identical properties as parts used to manufacture the original automotive. These problems visualised in Figure 5 are the reason for very stringent quality requirements set by OEMs and quality approvals required for all articles manufactured by the applicants. New articles or articles produced on a new production line have to undergo a regime of laboratory and field tests before OEMs can be supplied. More detailed information regarding quality approvals and qualification schemes is given in the AoA.

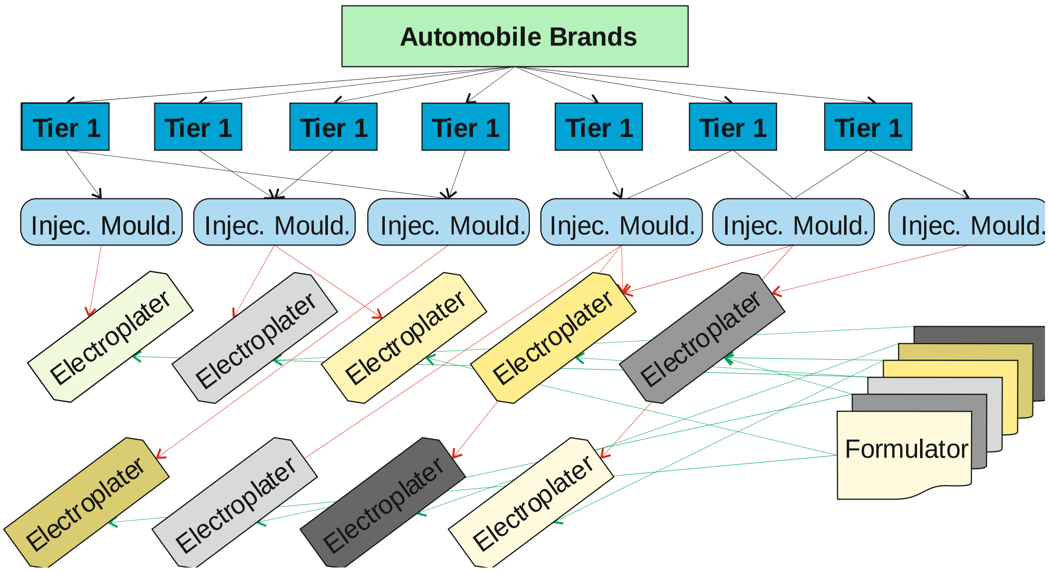

Figure 5: Automotive supply chain visualizing exemplarily the colour issue with Cr(III) coated parts (VDA in FGK Chrome 2020, 2015, adapted).

4 Source: DIN 53100 and several specifications from OEMs.

4. DEFINITION OF THE NON-USE SCENARIOS

4.1. Consequences of non-authorisation for the applicants

Background

The non-use scenarios (NUS) were developed based on the results of the AoA, taking into account experience with previous applications for authorisation and a series of bilateral discussions, site visits and meetings, conducted by independent consultants experienced in the process of developing such scenarios for EU regulatory purposes, in order to test the robustness of, validate and elaborate these scenarios.

Potential alternatives for chromium trioxide must be in compliance with the high demands and requirements regarding their critical performance properties within manufacturing processes and their final use. It is notable that the applicants are bound to strict qualification processes and quality standards provided by the OEMs. This can be seen to reflect the critical function (high quality surfaces) that chromium trioxide plays for PoPAA, which is essential for the automotive industry. For these reasons, a simple 1:1 substitution of chromium trioxide without prior approval by the OEMs is not possible for the applicants. According to the European Automobile Manufacturer Association (ACEA), the development of suitable alternatives for plating on plastics for current vehicle parts will require a further time period of at least 4 to 5 years followed by industrialisation of the technique and implementation in the supply chain. Acceptance of the applicant's reaction in the NUS by the OEMs is a mandatory requirement and therefore, it is difficult for the applicants to foresee which NUS is the most likely one. A further point to consider is the high complexity of supply chains in the automotive industry. The assembly of vehicles is performed in a complex network of manufacturing plants, which form a multi-tier system producing different parts and it is impossible for the applicants to foresee reactions of all companies involved in this complex supply chain. It is therefore impossible for the applicants to provide detailed estimations regarding potential time lines for industrial implementation of potential alternatives.

Reaction of the applicants in case of a non-granted authorisation

In case of a non-granted authorisation, the applicants being manufacturers of chrome-plated components operating in-house chrome plating facilities would first shut down all of their activities related to chrome plating, as chromium trioxide is necessary for the pre-treatment process of substrates (etching of the surfaces) and the plating process itself (see AoA for further details). In a second step, either implementation of NUS 1, NUS 2 or NUS 3 will follow and the applicants' production will only start after re-qualification of new production lines.

Since a detailed description of the reaction expected by the complex supply chain with its numerous actors is not possible, three potential non-use scenarios focusing on the impacts for the applicants have been selected and discussed in detail. The assessment focused on implementation of two currently non-feasible but promising alternative technologies (Cr(III) and PVD – see results of AoA) and relocation of sites to non-EEA countries. Non-use scenarios developed by the applicants include:

- Change of all applicants to Cr(III) process (NUS 1). This scenario implies the complete change including electroplating and etching, even if technical not possible at present. A complete substitution of Cr(VI) in etching and electroplating in parallel is mandatory for the applicants to avoid that impacts like losses due to downtime and efforts for re-qualification occur twice.
- Complete change to PVD systems by all applicants (NUS 2). This scenario implies the complete change of production to PVD although it is unclear whether quality requirements can be met using this technology and although it is clear that not all parts currently manufactured by the applicants can be produced using PVD (2K/3K components).
- Relocation of production facilities of all applicants to non-EEA countries (NUS 3).

Referring to the AoA, it should be mentioned that the NUS assessing costs for the implementation of non-feasible alternatives are based on the assumption that these techniques would be accepted by OEMs and that technical difficulties existing today would be solved until the sunset-date. It is very unlikely that this situation will come true and therefore in principle implementation of Cr(III) (NUS 1) and PVD (NUS 2) in reality cannot be considered as real options in case of a non-granted authorisation. The NUS can however provide information regarding efforts required to implement these technologies in future after technical feasibility is given and therefore can support the setting of a review period.

For the third NUS assessing relocation, it is worth to mention that in reality, not all applicants will be able to relocate their sites and some sites would be closed. The applicants' turnover related to PoPAA accounts for the highest share/major proportion of the business. Therefore, non-authorisation potentially also affects the viability of the remaining business activities. Since the surface of plastic parts is very sensitive, these parts often can only be transported overseas to electroplating baths in non-EEA countries using special containers. Thus, transportation costs need to be considered and at the same time, article manufacturers / assemblers / end-user companies would need to increase their storage capacities leading to higher storage costs. Therefore, in case of NUS 3 it is expected that not only electroplating is relocated but also further production steps like the injection moulding of the plastic parts to be treated or the assembly of components are likely to be relocated as well resulting in complete relocation of sites. Those companies that can afford a relocation of their facilities to a non-EEA country will do so (this step is even easier for companies that already have non-EEA production sites). However, small or medium enterprises (SMEs) report that they cannot afford a relocation, and therefore 'simply' cease their business activities. This is obvious when looking at the timelines and cost estimates for relocation as well as shutdown costs (e.g. compensations for dismissed workers, deconstruction and disposal of non-transferred equipment). Since it is very difficult for companies to anticipate reaction of investors in case of a non-granted authorisation, it was not possible to evaluate in detail how many sites would shut down and consequently a best-case NUS based on complete relocation of all sites was developed.

As already explained in Section 3.4, a situation where different suppliers (e.g. the applicants) use different technologies to produce parts for a specific car model will not be acceptable for OEMs due to strict requirements of identic properties (colour, corrosion resistance, haptic properties). Regarding the NUS, this means that when technical feasibility will be given in future, most likely OEMs will request a substitution of Cr(VI) by one alternative for the whole market (NUS 1 or NUS 2) or in case no alternative will become technically feasible the whole production will step-wise be relocated to non-EEA countries. Another reason why most likely only one alternative will be accepted by OEMs (besides different quality of parts produced by different potential alternatives) is the high effort for qualification of parts. In case of niche applications (single components with standalone character) special alternatives might be possible but for the majority of parts produced by the applicants a complete and market wide substitution by one alternative is required. Against this background, it is unlikely that different companies choose different NUS and the approach to discuss the specific NUS for all sites is justified.

Likelihood of NUS

Regarding the question, ‘which NUS is the most realistic one’ the following considerations need to be taken into account: Based on existing information provided in the AoA, Cr(III) and PVD technologies do not fulfil the customers’ requirements and it is impossible that this situation changes before the sunset date. NUS 1 and NUS 2, which would also require massive investments and considerable downtimes are therefore unlikely to come true. NUS 3 (relocation of sites) also requires time and results in prolonged downtimes, is however the most likely NUS from today’s perspective as it is the only technical feasible scenario. The downtimes correlated with all 3 NUS will result in an interruption of production and therefore an interruption of the supply chain for at least one year. It is clear that customers (OEMs) will look for other sources (non-EEA suppliers) of chromium surface treatment to cover their demand and to keep supply gaps (resulting in interruption of own production) as short as possible. When customers (OEMs) have established a new supply chain based on non-EEA suppliers, it is unlikely that they will turn back to the applicants after new production lines have been set up (independent for which NUS). New non-EEA suppliers need to be qualified by OEMs and new contracts including logistics need to be established. This requires significant efforts, which would occur a second time when OEMs want to return to the applicants. Non-EEA suppliers furthermore have the advantage that PoPAA using Cr(VI) is possible and they can profit from lower labour costs and lower efforts regarding RMM which provide advantages regarding competitiveness.

Therefore, it can be expected that after a supply chain based on non-EEA suppliers has been established by the OEMs, it is unlikely that the applicants will get back their market shares when returning to the market after implementation of alternatives or relocation. Some companies indicated that considering the negative impacts in the non-use scenarios, they might not be able to stay competitive anyways, which will result in loss of revenue, cancelation of contracts and finally the shutdown of sites. Against this background, it can reasonably expected that several sites would be closed and the assumption that all sites relocate to non-EEA countries is a best-case estimation.

In summary, all the single individual non-use scenarios reported by the applicants for the 22 sites lead to a different extent to considerable losses for the EEA, jeopardising European competitiveness and work places. To address all the uncertainties described above, it is assumed in this SEA as a best case scenario, that all production lines used to manufacture plastic components for the automotive industry are completely relocated to non-EEA territory. As a measure of impact, first the relocation costs and losses due to downtime have been considered. Further negative impacts to the European economy related to this scenario include of course leakage of know-how / technology to non-EEA countries, affecting Europe´s position as a technology leader – not only in surface technologies but also in tool-building, moulding and construction and design of innovative functional components with chromed surface.

Expected future developments regarding substitution of Cr(VI)

The majority of applicants reported that from their perspective substitution by Cr(III) is the most likely and preferred scenario for the future (assuming that technological problems will be solved and the approval of the customers will be achieved) with relocation to non-EEA as the second best option. Implementation of PVD is the most unlikely scenario as this in principle means that companies based on electroplating technologies would need to move to a technology they have no experience in. Moreover, it is not possible to apply the PVD technology for all manufactured parts due to limitations regarding geometry and size or as selective coating is required (2K/3K-parts). Besides quality problems, the immense investment costs for implementation of PVD and the uncertainties regarding costs and availability of equipment are additional drawbacks.

When looking at the three NUS, it is obvious that in future a step-wise implementation of alternatives as also preferred by the OEMs is mandatory for the applicants to stay competitive. The required investments need to be split over a longer period of time to guarantee reasonable financing and economic stability. Down-times resulting in a stop of production need to be avoided as otherwise the applicants will lose customers (market shares) and suffer from significant financial losses. An interruption of the automotive supply chain would have severe consequences for the whole industry (see Section 4.2). For both, the applicants and their customers a stepwise implementation of alternative technologies in parallel to the running production is the only realistic option guaranteeing that impacts on the automotive industry are limited as far as possible.

4.2. Consequences of non-authorisation for the supply chain

The AoA concluded that at the current stage of development, none of the tested alternatives can be seen as general replacement for plating on plastic for exterior and interior automotive applications. Even in case one of these alternatives could be considered as technically and economically feasible according to suppliers the following tasks would have to be carried out first before it can be used by an OEM for serial production of a vehicle.

Before materials and parts are considered for the development of a new car design, testing and approval at suppliers is necessary. Parallel to clearance by the OEM also new manufacturing processes would have to be adopted and established at the plating shops. It has to be confirmed that for the new process production capacities are sufficient. Only if technology and capacity approvals are granted a new material, coating or technology can be considered for concept development of a new car design by the OEMs.

Furthermore, in case chromium trioxide has to be replaced concomitantly for across the entire EU market, the following aspects need to be considered:

- None of the potential alternative technologies, as of today, has the production capacity to replace the market for electroplated parts.
- The supply chains as well as the production capacities for more than **Blank 1** of parts for the automotive sector, which are plated today, need to be built up from scratch.
- Sufficient production capacity with the new technology need to be identified, qualified and prove reliability.
- Field tests and acceptance tests with customers need to be performed. These ‘real life’ tests extend the duration of qualification. This means more personnel is required at OEM level in order to carry out tests for several thousands of new parts and surfaces need to be qualified at the same time.
- The interaction of the parts produced with the new technology needs to be assured on OEM level. The whole system of parts has to be evaluated, tested and qualified again. Likely, the surrounding parts will have to be redesigned to match the new technology's parts for a proper interplay. This again involves further supply chains, processes and suppliers (unpredictable time effects).

Consequently, the automotive industry considers a stepwise introduction of alternative technologies in new type-approved models (Directives 2005/64/EC and 2009/1/EC) to be the preferred approach, but this will not be feasible by the sunset date.

Being unable to source parts and components in the EEA, article manufacturers, assemblers and end-users of parts and components, treated with chromium trioxide in the production process will cover their demand at non-EEA suppliers and possibly relocate parts of their final assembly lines to non-EEA countries (partly assembling subunits and importing these). This will further increase the loss of value-added within the EEA.

With EU based OEM’s using 70-80% EU suppliers (and non EU based OEM´s using 20-50% EU suppliers) a change to non EU suppliers would have a huge impact on the EU economy. With more than 16 million cars being built every year, building up sufficient capacity in Europe to cover all relevant parts is not possible by the sunset date as discussed in the previous section. Moreover the direct supply chain will be also affected. The plating job is often one by Tier 3. It is likely that also the process of Tier 4 (injection moulding) as well as the process of Tier 2 (assembly line for e.g. air discharger, radio panels) will also move to Non-EEA suppliers. In these processes a lot of low-skilled jobs are involved.

As a final consequence, the entire European supply chain from the plating shops upwards will move to a non-EEA country. Also subsequent parts of the supply chain may relocate over time.

Furthermore, the health environment for workers will not improve due to the relocation because of much less stringent regulations in non-EEA countries[5].

All these consequences are impossible to quantify based on information available to the applicants and with reasonable effort. It is however clear that due to the sheer number of parts supplied by the applicants to the European automotive manufacturers, it will not be possible for OEMs to cover the loss of EU suppliers due to a non-granted authorisation by non-EEA supply. Consequently, a temporary interruption of the just-in-time supply chain and therefore temporary interruption of automotive manufacture can be expected to occur.

[5] This is true for all industry sectors.

5. INFORMATION FOR THE LENGTH OF THE REVIEW PERIOD

In addition to the findings of the AoA, the following sections shall exemplary highlight the special characteristics inherent to the affected industry to justify a minimum review period of **12 years** for the use of chromium trioxide in PoPAA.

There are several facts to consider when setting an appropriate review period:

- Expected progress regarding R&D and availability of alternatives
- Efforts (e.g. investment and timing) for industrial implementation of future alternatives
- Supply chain structure and competition from non-EEA countries

As explained in the AoA, alternatives for Cr(VI) in PoPAA are to be expected in the future, but at present, no alternative is available which would provide the properties demanded by the applicants' clients. Potential alternatives with promising R&D status regarding technical feasibility are Cr(III) electrolytes and PVD technologies. The AoA provides details regarding currently existing limitations and forecasts regarding R&D time required to solve existing problems. Based on the assumption that no technological problems exist, the NUS discussed in this SEA provide information regarding efforts and time required to implement the potential alternatives Cr(III) and PVD. The NUS demonstrate that significant efforts are necessary to implement the alternatives at the applicants' sites independent from when they will become technical feasible.

Section 3.4 provides some considerations regarding the complexity of the automotive industry supply chain. To prevent failures of products, the automotive industry has rigorous testing and validation procedures in place. These procedures include laboratory tests, summer and winter tests and continuous-operation tests. Before alternative technologies can be extended to large-scale production with the aim to completely substitute Cr(VI) electroplating, all adapted production lines and articles manufactured with new technologies (approximately 10,000 articles) have to be qualified in cooperation with OEMs. Laboratory capacities at the applicants' sites and at the OEMs are limited which means that complete substitution at a specific point of time would overload the applicants and the OEMs quality testing capacities. Attempts to replace components with alternatives not evaluated and tested thoroughly enough lead to failures in the field and costly product recalls. Such recalls have the potential to damage carefully developed brand equity, spoil customers' quality perceptions, tarnish a company's reputation and lead to losses of both revenue and market share.

In addition, to keep the applicants' business in Europe, production lines based on alternative technologies with equal capacity to existing Cr(VI) electroplating lines are required. The applicants produce approximately more than **Blank 1**[6] electroplated parts per year at their 22 sites located in Germany, Spain, Czech Republic and Slovakia. The NUS show that a short-term implementation of alternative technologies with sufficient capacity at all sites of the applicants in parallel is impossible due to limited availability of equipment and service providers as well as due to the high investment costs, which only can be handled step-wise by the applicants during a long review period. Implementation of alternative technologies always requires a stop of production. To avoid severe losses of production due to down time for the applicants and a subsequent interruption of the automotive supply chain, it will be mandatory to plan and organise substitution activities in a way that guarantees continued production (which is not possible in case of immediate substitution). Interruption of the applicants' production for more than a few weeks is inacceptable as the lack of availability of chrome-plated parts could finally affect vehicle production volumes, which, when considering the economic importance of the automotive industry to the European economy, could have widespread negative effects. Furthermore, a long down-time, which can only be avoided by a gradual process change, would lead to a replacement of the applicants in the supply chain by non-EEA suppliers. Once the components of a new supplier are qualified by the OEMs, a return to the applicants is very unlikely, since a significant amount of time and money has to be invested again.

The only reasonable approach is the step-wise establishment of a completely Cr(VI) free process. A complete change to a Cr(III) based plating of the components, which is the only possible scenario in order to avoid twofold and costly qualifications of components, takes years and is mainly limited by R&D progresses for the etching step.

Another point to consider is that the applicants supply parts to different actors in the automotive supply chain and their parts are consequently present in cars of different OEMs. A situation where only single customers accept an alternative would require parallel production with different technologies and several consecutive substitution activities (multiplication of substitution efforts) until every customer has accepted the alternative. To keep substitution costs in an acceptable range and to avoid loss of competitiveness (non-EEA competitors do not need to substitute) it is mandatory that the whole market for PoPAA switches to alternatives in a coordinated way.

A step-wise coordinated substitution is also mandatory for the OEMs. The automotive industry relies on long-term production cycles, which need a stable and equally long guarantee of supply of components and parts. The average life cycle of a car model is usually more than 20 years (Figure 6).

6 An increase in demand for chrome-plated plastic components is expected in the near future due to (i) growth in non-EEA automotive markets, and (ii) demand for light-weight products to reduce fuel consumption and CO_2 emissions.

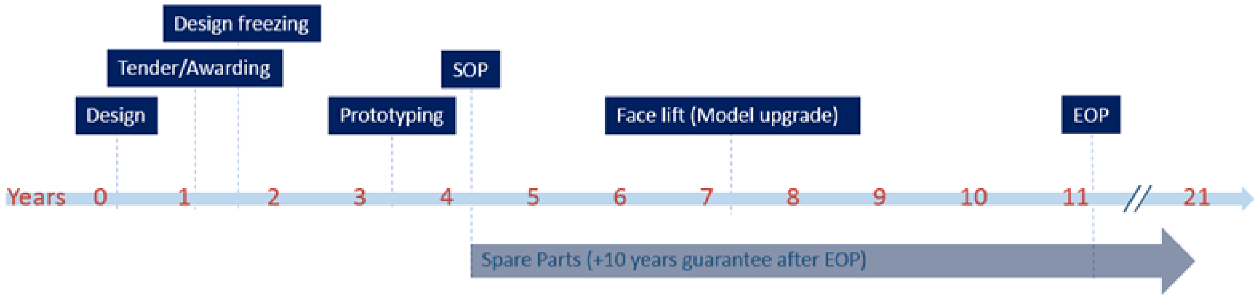

Figure 6: Typical lifetime of a car model (According to VDA in FGK Chrom 2020, 2015).

Before materials and parts are considered for the development of a new car design, testing and approval at suppliers is necessary. Parallel to clearance by the OEMs also manufacturing processes have to be adopted and established at the suppliers. Sufficient production capacity has to be confirmed for the new process. Only if technology and capacity approvals are granted a new material, coating or technology can be considered for concept development of a new car design. Consequently, the automotive industry considers a stepwise introduction of alternative technologies in new type-approved models (Directives 2005/64/EC and 2009/1/EC) to be the preferred approach, but this will not be feasible within a few years and definitely not by the sunset date.

Changing parts during the on-going production of a car model is difficult as the design of the parts (e.g. chrome plated parts) has been defined during development of the car design. The size and dimensions of parts used to produce cars need to fit with each other and only little variation is acceptable. In case the production process of parts is changed, it needs to be guaranteed that parts delivered by the respective supplier have similar size and quality as the original parts. A change to alternative technologies can cause changes in function, geometry, durability and may have unexpected impacts on other related parts. Taking into account that chrome-treated parts used by OEMs to manufacture a car come from different PoPAA suppliers, it is obvious that significant efforts by OEMs will be required to enable implementation of alternatives at the applicants' sites and a close cooperation of OEMs and the applicants will be necessary.

Past model service parts are typically provided during the production life of the vehicle but also for a minimum of ten years after serial production has finished. Changing one or more substances used in the current past model service parts is not a simple, straightforward task; it requires serious efforts for development and testing, which is in many cases neither economically nor technically feasible when one considers the low production volumes of these service parts. Allocating the costs of development and testing to such a small number of products would drive the prices of past model service parts produced by European manufacturers to an excessively high level, and encourage the import of components and parts from outside the EEA. This business consequently requires a long review period.

Taking all that into account, it is not astonishing that already today, suppliers are in a dilemma to sign new contracts with OEMs for car model production, which will start years after the sunset date. It is a high-risk investment decision since supplier directions of car producers today in principle make it compulsory to run the process with chromium trioxide like established for decades. The applicants have long term contracts with their customers and need Cr(VI) based PoPAA to meet the requirements as long as the customers accept parts based on alternative technologies. A non-granted authorisation or a short review period would therefore mean that contracts cannot be fulfilled and may cause penalties. Only a long review period allows the applicants to plan future activities and investments and to sign new contracts.

With regard to current vehicle parts and European vehicle production, an adequate review period is absolutely necessary to ensure that alternatives are thoroughly evaluated (to avoid failures in the field), ready for large scale production and capacities are built in Europe to ensure that production volumes are not affected, that the European automotive market remains competitive on a global scale and to allow an efficient information exchange through a very long chain of suppliers.

According to the European Automobile Manufacturer Association (ACEA), the development of suitable alternatives for plating on plastics for current vehicle parts will require a further time period of at least 4 to 5 years followed by industrialisation of the technique and implementation in the supply chain. This is in line with the findings of the AoA. Considering the time lines for implementation of alternative technologies provided in the NUS and the above mentioned preconditions for full substitution of the whole PoPAA market, it is clear that industrialisation of alternatives will definitely not be possible within a normal review period. As can be seen from the NUS, the most promising alternative is electroplating based on Cr(III). Assuming that technical feasibility would be given 2-3 years after the sunset date (which is rather optimistic) discussions with OEMs to plan implementation could start in 2020. Against this background, it is obvious that complete substitution until 2024 is completely unrealistic and the applicants would definitely need to prepare a review of the AfA in 2023.

6. METHODOLOGY

ECHA (2011) makes it clear that a quantitative analysis is strongly recommended to underpin an application for authorisation[7] and recommends a cost-benefit analysis (CBA) as the preferred tool for quantitative analysis[8] (1). This preference has further been underlined in the current practice of Applications for Authorisation where both the costs and benefits have been quantified and compared[9]. Furthermore, it has been clear in the seminars and presentations given by ECHA that a full cost-benefit analysis, i.e. a fully quantitative SEA including the monetisation of the health impacts, would make it much easier for the Socio-Economic Analysis Committee (SEAC) to compare the costs of non-authorisation with possible remaining risks in the case of authorisation. For that reason, as it is highly recommended by ECHA Guidance, a monetisation of the different impacts is carried out in order to provide a more reliable assessment for this SEA.

An analysis of the (1) monetised health impacts, and (2) socio-economic impacts is presented here to allow an easier evaluation of the potential risks related to the authorisation. The aim of this analysis is to support the findings of the qualitative description, where it has been concluded that the benefits of continued use of chromium trioxide would be substantial, while the remaining risks would be very well managed and limited, following an authorisation. The analysis is built on and takes into account evidence gathered during the preparation of the CSR, AoA and SEA.

The applicants refer to and utilise the processes, methods, tools and values (e.g. the dose-response relationship) prescribed under ECHA (2011) and ECHA (2013) (1) (2). However, the applicants do not and should not by preparing this quantified cost-benefit analysis or otherwise be construed to endorse, support, or otherwise accept the approach to the monetisation of health impacts. Independent studies such as willingness to pay reports have been referenced as required in order to give an estimate of the order of magnitude of the residual health risk of the use as authorised in the cost-benefit analysis framework. Given that the purpose of this analysis is to give an order of magnitude estimation, the applicant considers that the monetised health impacts calculated

7 For example, the 4th paragraph of the box titled 'How to identify and assess impacts?' at page 22 of the Guidance on the Preparation of Socio-Economic Analysis as part of an Application for Authorisation which states monetisation should ideally be carried out.

8 Section 4.1 of the Guidance on the Preparation of Socio-Economic Analysis as part of an Application for Authorisation.

9 See e.g. the public versions of the applications available at http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/applications-for-authorisation-previous-consultations and http://echa.europa.eu/web/guest/addressing-chemicals-of-concern/authorisation/applications-for-authorisation [Cited: 15 November 2014].

according to the prescribed ECHA method have no real-world, commercial or legal relevance or merit.

6.1. General approach

The SEA has been conducted in accordance with the approach set out in the ECHA Guidance on the Preparation of socio-economic analysis as part of an application for authorisation (1). The reader is referred to the guidance for appropriate context and general information on approach to the SEA, while more specific aspects relevant to this document are discussed below.

Specific data used for the analysis of impacts in the SEA at hand was gathered by the use of questionnaires sent to the responsible staff in the different departments of the applicants. Information has been collected separately for each site operated by the applicants.

In addition, several site visits provided supportive information to be able to reflect the on-site situations in the authorisation dossiers. Additional benefits from the site visits were e.g. clarification of questions of details, discussion of non-use scenarios and maximisation of understanding of the uses of chromium trioxide and the production processes.

As an underlying basis for the assessment of impacts in this socio-economic analysis, the estimation of health impacts was based on worst-case assumptions compared to purposefully conservative calculations of social and economic impacts.

For example, the calculation of health impacts is based on upper bound estimates of people potentially exposed (maximum number of potentially exposed workers) and the upper bound of exposure times and values, as elaborated in the CSR. These derived values, therefore, can be considered worst-case estimates. In this sense, while the values themselves have no real-world, commercial or legal relevance or merit, the broad comparison of the health impact with social and economic impacts can be considered a relative measure of their scale. For more detailed information regarding worst-case exposure assumptions (e.g. regarding frequency of activities) the reader is referred to the CSR.

By contrast, the calculation of social and economic impacts is based on the lower bound values provided by the applicants (lower bound of indicated investment costs and down-time for reconstruction/re-location). It should be noted that the collection of data from the applicants for the purpose of the SEA was subject to competition rules and is therefore neutralised and aggregated. Data provided by applicants for specific sites has been evaluated and summed up in a way that best-case estimations are presented for the different NUS.

As a consequence, human health impacts are highly overestimated and socio-economic impacts are very likely to be underestimated.

6.2. Assessment of health impacts

In accordance with the CSR the risk assessment for workers exposed in this SEA is restricted to inhalation of airborne residues of chromium trioxide (lung cancer). For the general population, inhalation exposure to Cr(VI) and oral exposure to Cr(VI) via the food chain is also taken into account. Oral exposure via the food chain leads to an additional risk of intestinal cancer.

6.2.1 Quantitative health impact assessment of workers

The worst-case assessment of health risks within this SEA utilises the results of a study endorsed by ECHA identifying the reference dose-response relationship for carcinogenicity of Cr(VI) (2)[10]. This paper has been agreed on at the RAC-27 meeting on 04 December 2013. These results on the carcinogenicity dose-response analysis of Cr(VI) containing substances are acknowledged to be the preferred approach of the Committee for Risk Assessment (RAC) and the Committee for Socio-Economic Analysis (SEAC) and therefore have been used as a methodology for the assessment of health risks in this SEA.

Accepting this, the following steps are necessary to complete the health impact assessment according to the ECHA methodology and a worst-case approach:

- Evaluation of potential work exposure;
- Estimation of additional cancer cases relative to the baseline lifetime risk of developing the disease;
- Assessment of fatality rates (per cent) with reference to available empirical data;
- Monetary valuation of fatal and non-fatal cancer risks based on the new willingness to pay (WTP) study published by ECHA in 2015 (6).

These four consecutive steps are explained in detail in the following.

[10] By reference to this, the applicant neither agrees nor disagrees with this dose-response relationship. However, the applicants acknowledge that the dose-response relationship is likely to be conservative and protective of human health, particularly considering the extrapolated linear relationship at low dose exposure concentrations.

6.2.1.1 Data gathering on potential work exposure

For the assessment of potential worker exposure, the maximum number of potentially exposed workers reported by the applicants for each relevant activity and each site in the questionnaires and the worst-case exposure values from the CSR are taken into account. In this course, the specific WCSs given in the CSR are used as basis. For further information regarding exposure values, please consider the CSR.

6.2.1.2 Estimation of additional cancer cases in relation to baseline

The dose-response relationship for Cr(VI) with regard to lung cancer has been discussed in recent research published by ECHA (2). These dose-response functions of an excess risk for carcinogenic effects have been used as the basis for this assessment.

For the calculation of health impacts related to lung cancer, **excess lifetime risk** (ELR) is defined as the additional or extra risk of developing cancer due to exposure to a toxic substance incurred over the lifetime of an individual. Note that developing cancer may occur during working life or after retirement.

Linear exposure-risk relationship for lung cancer as estimated by ECHA (2):

$$Unit\ occupational\ excess\ lifetime\ risk = 4\text{E-}03\ per\ \mu g\ Cr(VI)/m^3$$

The dose-response relationship agreed upon by RAC refers to a working lifetime exposure with continuous working-daily exposure. As an average over different countries and economic sectors, full-time employee contracts (8 hours per day) and a working lifetime of 40 years are taken as a basis (2). Note that 8 working hours per day or 40 working hours per week, as well as 40 years per working life are explicit parameters used for the Full-Time working Equivalent (FTE) underlying the exposure-response functions (2), p. 5, whereas 260 working days per year are implicitly given through the dose-response curve.

Adaptation factors for time frame of exposure

In order to apply this exposure-risk relationship to the case of authorisation, it has to be adapted according to the time frames used in this AfA.

Therefore, the following factors are used to adapt the exposure-risk relationship to the respective situation of this AfA:

- Factor for adaptation to the respective review period (years of authorisation granted up to the next revision envisaged)

$$\frac{envisaged\ review\ period\ [years]}{40\ years}$$

- Factor for adaptation to the actual working days per year[11]

$$\frac{working\ days\ per\ year}{260\ days}$$

Due to the fact that exposure values derived in the CSR are 8 hour Time Weighted Average (TWA) concentrations, a correction for the actual exposure time per day is not needed. For activities performed not on a daily basis, the frequency of activities has been taken into account in the CSR and the presented exposure estimates are already corrected respectively (e.g. in case an activity is performed only once a week, the exposure estimate presented in the CSR already is an average long-term exposure corrected for frequency). This means that the factor for adaptation of the actual working days has only been applied for daily activities. Depending on working days per year at specific sites, individual correction factors have been determined for each site and used in the further assessment.

Methodology for the estimation of additional lung cancer cases

For an individual person, the excess lifetime lung cancer mortality risk derived in the ECHA paper (2) indicates the differential in probability to die of lung cancer during the future life, i.e. the increase in probability compared to the baseline risk for an individual to die from this disease.

As described above and in line with ECHA, ELR of mortality associated with lung cancer = 4E-03 per µg Cr(VI) /m^3 x concentration [µg Cr(VI) /m^3] (due to an exposure over the whole working lifetime of 40 years, which is higher than the relevant time frame for the intended authorisation).

Excess risk used in this equation is defined as:

$$P_{excess} = P(x) - P(0)$$

with

$$P_{excess}(x) = Excess\ risk\ at\ exposure\ x$$

$$P(x) = lifetime\ risk\ of\ persons\ exposed\ for\ dying\ from\ lung\ cancer$$

$$P(0) = Background\ risk\ (lifetime\ risk\ of\ a\ non-exposed\ comparison\ group)$$

It has to be emphasised that $P_{excess}(x)$ is an additional risk, the unit is the expected number of additional lung cancer deaths of a population exposed by a concentration x in the sum (2).

[11] 260 days per year are not explicitly stated in the RAC paper (RAC/27/2013/06 Rev.1), but are implicitly assumed by RAC. This can be shown by comparing the dose-response relationships for workers and the general population.

In the source of ECHA (2), based on the research of the ETeSS consortium (7), and in underlying studies, excess risk is used in absolute terms, not percentage points. The excess risk $P_{excess}(x)$ is linear, i.e. proportional both to individual exposure and to persons exposed. Therefore, exposures of different persons can be added.

Consequently, the aggregated excess risk is the expected value of additional lung cancer deaths due to an exposure.

The calculation of the excess risk (i.e. additional lung cancer deaths) over all employees exposed is calculated per WCS by multiplying the individual excess risk times the respective number of workers exposed. Then, the excess risk of all WCS are summed up. Thus, the estimated amount of additional lung cancer deaths is the expected value due to a continued use of Cr(VI) for the respective time frame allowed by an authorisation up to the next revision.

According to the ECHA document (2), the term used is '*excess lifetime lung cancer mortality risk*'. This is also consistent with the results of ETeSS (2013) (7) where the respective table of a preliminary report is titled '*[u]nit occupational excess lifetime risks of lung cancer death determined by different authorities or publications*'. This signifies that the dose-response function developed refers only to additional lung cancers ending fatal. In this study, only data on deaths caused by lung cancer have been taken into account for the estimation of the dose-response relationship. This will be included in step 4 of this methodology (Monetary valuation of fatal and non-fatal cancer risks).

6.2.1.3 Estimation of average fatality rates in per cent, based on empirical data from EU-27

The individual development of cancer diseases may be fatal or non-fatal. Non-fatal cancer is defined as cancer not causing a premature death, i.e. life expectancy is not reduced due to the cancer disease, whereas fatal cancer is defined as cancer leading to premature death. This distinction is important when applying the ECHA Guidance on socio-economic analysis in order to use consistent categories of monetary values.

For the determination of fatality rates for lung cancer, demographic data on age-specific cancer incidences and mortality rates have been taken into account; these are mainly:

- age profile of a population;
- gender profile of a population;
- relationship of risk of developing the disease and risk of dying from the disease.

For lung cancer, data of the International Agency for Research on Cancer (IARC) (8) for the EU-27, as well as data for the EU Member States, showing the age and gender profile of cancer risks in more detail have been analysed and compared to selected other EU Member States with similar data collection sets (9).

Although the incidence risk and the mortality risk themselves are higher for men than for women, the relationship between incidence and mortality risk (i.e. the fatality rate) shows, apart from random fluctuations, there exist no major differences between males and females.

It has to be emphasised that any structural differences in the baseline risks (e.g. between men and women, between different EU Member States or between different age groups) do not influence the estimation of incremental cancer risks due to exposure to Cr(VI). Therefore, neither the share of male and female workers exposed at work nor the exact age of workers influence the outcome of the estimations.

The fatality rate is an important parameter for a monetary-based valuation of cancer risks. The reference dose-response relationship estimates additional fatal cancer risks only. A full health impact assessment will also consider lung cancer cases that do not result in fatality. Average mortality rates for lung cancer in the EU-27 are 82.8% for both sexes. This value will be used for further analyses in this SEA.[12]

6.2.1.4 Monetary valuation of fatal and non-fatal cancer risks

In order to evaluate the additional cancer cases in monetary terms, monetary values as suggested by the latest study of the Charles University Prague on behalf of ECHA (6) are used.

In the study of Alberini and Ščasný (6), a **WTP** to avoid a statistical case of a cancer [= Value of a statistical case of a cancer (VSCC)] – no matter whether ending non-fatal or fatal – of **EUR 396,000 (2014)** and a Value of a Statistical Life (VSL) for cancer of **EUR 5,000,000 (2014)** are given and recommended to be used for the EU-28. These rounded values are based on an empirical WTP study from the year 2014 using a discrete choice experiment, explicitly addressing cancer risks and 5-year cancer survival probabilities. However, different cancer types such as lung cancer, leukaemia or renal cancers have not been specified in the design. Therefore, these values refer to the whole spectrum of cancers.

We understand from the questionnaire design and the description of the econometric approach used in this study that for each cancer ending fatal, the VSL value for mortality and the VSCC of one cancer case (i.e. the case of one cancer incidence), have to be added. This is because both characteristics

- Chance of getting cancer within the next 5 years, and

12 In these figures of EU-27, Croatia is not yet included. Respective IARC data for Croatia (with a relatively low population) show an even higher mortality rate of 91.3% for both sexes in the year 2012, but due to the use of relative rates for calculation they cannot directly be aggregated to EU-28.Therefore, the EU-27 parameter is used.

- Chance of survival at 5 years from the diagnosis (if you get cancer)

are varied as variables separately from each other in the choice experiment.

Each cancer ending non-fatal, however, should be evaluated in monetary terms with the VSCC only. Consistently, this methodological approach is also used in the analysis of health impacts in Section 7.1.

Since values are based on the year 2014, they are adjusted to the respective year of the sunset date [the base year for the calculation of net present values (NPV) of costs and benefits] by using gross domestic product (GDP) deflator indexes. This will be explained in the following.

Implementation of a price adjuster

In this SEA, costs and benefits are made comparable by basing them to the year of the sunset date (the sunset date is used as the reference year for all cost estimations of the SEA). Therefore, health risks as well as additional costs relating to the continued use of chromium trioxide in case of the authorisation are based to the year of the sunset date.

To adjust the WTP values to the base year, these values are multiplied by a price adjuster, which is the appropriate price index of the reference year divided by the appropriate price index of the year 2010. When using as appropriate price index the GDP deflator of the EU-28 issued by the statistical office of the European Union (EUROSTAT), complete data could be gathered up to the year 2014. The quarterly deflator is calculated from seasonally adjusted GDP values and rescaled so that 2010 equals 100. For 2014, which is the last year with complete data sets, the deflators of the four quarters range from 105.3 (first quarter) to 106.6 (fourth quarter), with an arithmetic mean of 106.0 for the four quarters.[13] A price index development from 100.0 (in 2010 as the starting point where the index is based on) up to 106.0 in 2014 is equivalent to an **average annual growth factor of 1.015** (geometric mean over 4 years from 2010 to 2014). We assume that in the average the calculated rate of price increase will continue in future from 2014 up to the reference year; therefore, the factor of **1.015 per year** is applied to extrapolate the price index development into the future, i.e. between 2014 and the reference year.

Adjusting the WTP values by the GDP deflator from 2014 to the year for which the sunset date is scheduled (i.e. it is implicitly assumed that WTP increases by the same rate as the GDP in average) leads to the respective values for cancer cases. The share of non-fatal cancers has to be added to the estimated number of fatal cancers (see Table 1). Following the recommendations of Alberini and

[13] Source: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=teina110 [Cited: 24 August 2015]. Note that earlier versions of this EUROSTAT source still used an index based on the year 2000 = 100, which was the basis for the calculations in previous SEA documents.

Ščasný (6), it was decided to use the monetary values that are shown in Table 1 for the evaluation of cancer cases.

Table 1: Monetary values for fatal and non-fatal cancer risks, based on Alberini and Ščasný (6)

	Value of a Statistical Case for a Cancer (VSCC)	**Value of Statistical Life (VSL) for cancer**	**Value for a fatal cancer case: VSL + VSCC**
2014 WTP value based on Alberini and Ščasný – starting value	EUR 396,000	EUR 5,000,000	EUR 5,396,000
Adjusting the 2014 values to the sunset date (2017)	$1.015^{\text{sunset year – 2014}}$	$1.015^{\text{sunset year – 2014}}$	$1.015^{\text{sunset year – 2014}}$
→ 2017 WTP value	EUR 414,089	EUR 5,228,392	**EUR 5,642,481**

As stated before, the average mortality rate for lung cancer in the European Union (EU) is 82.8%. This means that an additional share of 82.8%/17.2% non-fatal cancers per fatal lung cancer has to be added to the WTP value for a fatal cancer case to get to the total WTP for fatal and non-fatal cancers (see below).

Adding the share of non-fatal cancer cases per fatal cancer case to get the total WTP	
Probability of lung cancer ending non-fatal/fatal (EU-27 average)	17.2 %
→ Additional occurrence of non-fatal lung cancer cases per one fatal cancer case	17.2 % / 82.8 % (see above) = **0.208** non-fatal cancer cases per fatal cancer case
→ 2017 WTP value for an additional share of non-fatal cancers per fatal cancer case	**EUR 86,130** (0.208 x EUR 414,089)
→ 2017 Total WTP for one statistical fatal cancer case incl. 0.208 non-fatal cancer cases per fatal cancer case	**EUR 5,728,611** (= EUR 5,642,481 + EUR 86,130)

In order to monetise the excess risk (i.e. additional fatal lung cancers) relating to the authorisation of the continued use of chromium trioxide, first the excess risk is calculated according to the following equation:

Individual ELR per WCS

$$ELR = \frac{review\ period\ [years]}{40\ years} \times \frac{working\ days\ per\ year}{260\ days} \times \text{ 4E-03 per } \frac{\mu\text{g Cr(VI)}}{\text{m}^3} \times \text{ concentration } \left[\frac{\mu\text{g Cr(VI)}}{\text{m}^3}\right]$$

where

$$\text{concentration } \left[\frac{\mu\text{g Cr(VI)}}{\text{m}^3}\right]$$

represents the Cr(VI) concentration taken from the ES in the CSR.

As already mentioned before, the correction factor for working days is only applied for daily activities.

Total ELR over all WCSs and workers

The calculation of the excess risk (i.e. additional fatal lung cancers) over all employees potentially exposed is calculated per WCS by multiplying the individual excess risk times with the respective number of workers potentially exposed. Then, the excess risk of all WCS are summed up. Thus, the estimated amount of additional fatal lung cancers is the expected value due to a continued use of Cr(VI) for the respective time frame allowed by an authorisation up to the next revision.

$$\sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} (\boldsymbol{ELR_i} \times \boldsymbol{number\ of\ workers_i})$$

i = WCS

Monetisation of the total ELR

In the next step, the monetised value for additional lung cancer cases (fatal and non-fatal) is calculated by multiplication with the WTP value adjusted to the year of the sunset date. Following this methodology, the actual assessment of health impacts related to the authorisation of the continued use of chromium trioxide is conducted in Section 7.1.

6.2.2 Quantitative health impact assessment of the general population

According to ECHA Guidance on information requirements and chemical safety assessment Chapter R.16: Environmental exposure estimation, version 2.1, October 2012 (ECHA Guidance R.16) (10), potential exposure via the environment should be assessed on two spatial scales: locally in the vicinity of point sources of release to the environment, and regionally for a larger area which includes the point source or all point sources in that area. Releases at the continental scale are not used as endpoints for exposure. The end results of the exposure estimation are predicted environmental concentrations (PECs) in the environmental compartments for both local and regional scale which have been calculated in the ES.

6.2.2.1 Data gathering on potential exposure MvE

Exposure concentrations

The regional predicted environmental concentration (= MvE regional[14]) derived in the CSR has been assumed to represent the average exposure concentration for the general population. The local predicted environmental concentration (= MvE local), based on modelled data, is used to calculate potential risks for on-site workers not directly exposed as well as the direct neighbourhood. The respective values for MvE oral provided in the CSR have been taken as basis for calculation of impacts resulting from oral uptake via the food chain.

Number of potentially exposed people

<u>MvE regional</u>

For calculation of the health impacts for the **general population** resulting from potential exposure of Man via the Environment (MvE), the total number of people living in an area 200 km x 200 km around the sites that will use chromium trioxide are considered in terms of potential exposure to MvE regional. As a default recommended as the basis of the local exposure assessment in the ECHA Guidance R.16 (10), a value of **20,000,000 people per** area of 200 km x 200 km is considered in terms of potentially exposed people for MvE regional. This number has been described to represent the average number of persons living in such an area in Central Europe. Most of the applicants' sites are located in Germany with one site in Spain, two sites in Czeck Republic and one site in Slovakia. To determine the relevant regional area of expose, a map showing the location of the individual sites was created (see Figure 7). For each site an area of 200 km x 200 km was marked in the map and the overall area in Europe covered by all of the single areas together has

[14] The calculated $PEC_{regional}$ represents the average concentration in an area of 200 x 200 km around the point sources.

been evaluated. Against the background that considerable areas overlap, as shown a total area of maximum 10 x 200 km x 200 km has to be considered for the applicants' sites.

Figure 7: Location of sites and potentially exposed areas (one box = area of 200 km x 200 km).

The total number of people potentially exposed on a regional scale is then calculated as 20,000,000 multiplied by the relevant areas (10 areas) in which sites using Cr(VI) are located.

MvE local

The local exposure assessment with MvE local considers workers that do not work with Cr(VI), but work in the vicinity (potentially indirectly exposed workers) as well as people living in the direct neighbourhood of the sites. As a default, the total number of people potentially exposed on a local scale is calculated as 10,000. This number of people is recommended as the basis of the local exposure assessment in the ECHA Guidance R.16 (10). The total number of people exposed on a local scale is then calculated as 10,000 multiplied by the number of sites using Cr(VI).

Since there is no basis for a reliable distinction between the number of potentially indirectly exposed workers and people living in the neighbourhood, the dose-response curve for the general population is taken as a basis following the worst-case approach, i.e. workers would be exposed for less time, e.g. 8 hours per day for 260 days, than the general population (24 hours per day for 365 days of exposure). Table 2 summarises the most important input parameters in case of single sites.

Table 2: Overview of the most important input parameters for calculation of health impacts for MvE

Group of potentially exposed people		**Number of potentially exposed people**	**Exposure concentration to be used from the ES**	**Dose-response curve for**
Indirectly exposed	Potentially indirectly exposed workers and direct neighbourhood per site	10,000	PEC_{local}	General population
Indirectly exposed	General population in an area of 200 km x 200 km around the site	20,000,000	$PEC_{regional}$	General population

6.2.2.2 Estimation of additional cancer cases in relation to baseline

The methodology used for calculation of additional cancer cases follows the methodology described in Section 6.2.1.2.

In addition to inhalation exposure to Cr(VI) via the environment, for the general population oral exposure to Cr(VI) via the food chain is also taken into respect, which leads to an additional risk of intestinal cancer. Dose-response relationships, but also fatality rates and therefore monetary valuation of cancer cases are different for intestinal cancer than for lung cancer.

The dose-response relationship for Cr(VI) with regard to lung and intestinal cancer for the general population has been discussed in recent research published by ECHA (2).

Linear exposure-risk relationship for lung cancer as estimated by ECHA (2):

$$Unit\ excess\ lifetime\ risk = 2.9\text{E-}02\ per\ \mu g\ Cr(VI)/m^3$$

Linear exposure-risk relationship for intestinal cancer as estimated by ECHA (2):

$$Unit\ excess\ lifetime\ risk = 8\text{E-}04\ per\ \mu g\ Cr(VI)/kg\ bw/day$$

It has to be emphasised that for intestinal cancer the dose-response relationship refers to the incidence and not to fatality of cancer, unlike for lung cancer. According to the ECHA document (2), the term used is '*excess lifetime intestinal cancer risk*'. This signifies that the dose-response function developed refers to additional intestinal cancers ending either fatal or non-fatal. In this study, data on cancer incidence, not cancer mortality have been taken into account for the estimation of the dose-response relationship. This will be included in step 4 of this methodology (Monetary valuation of fatal and non-fatal cancer risks).

Adaption factor

The dose-response curve for the general population considers 365 days of exposure and 70 years of lifetime. Accordingly, it is necessary to adjust the exposure duration to the foreseen review period of 12 years by the factor 12/70.

6.2.2.3 Estimation of average fatality rates in %, based on empirical data from EU-27

As explained in Section 6.2.1 the individual development of cancer diseases may be fatal or non-fatal. The fatality rate is an important parameter for a monetary-based valuation of cancer risks.

As stated above the reference dose-response relationship for lung cancer estimates the fatal cancer risks, whereas the reference dose-response relationship for intestinal cancer estimates both fatal and non-fatal cancer risks.

According to IARC the average mortality rates for lung and intestinal cancer in the EU-27 are 82.8% and 39.7%, respectively, for both sexes (8) and (11), i.e. intestinal cancer has a more favourable survival prognosis than lung cancer. This value will be used for further analyses in this SEA.[15]

6.2.2.4 Monetary valuation of fatal and non-fatal cancer risks

Analogous to the approach in Section 6.2.1 the additional cancer cases are evaluated in monetary terms, monetary values as suggested by the latest study of the Charles University Prague on behalf of ECHA (6).

As stated before, the average mortality rate for lung cancer and intestinal in the European Union (EU) are 82.8% and 39.7%, respectively.

This means that an additional share of 82.8%/17.2% (= 0.208) non-fatal lung cancers per fatal lung cancer has to be added to the WTP value for a fatal cancer case to get to the total WTP for fatal and non-fatal lung cancers (see Table 3). This also means that 60.3% of additional intestinal cancers do not lead to a reduction of life expectancy, and only for the percentage of 39.7% the VSL has to be added (see Table 3).

As stated before, in contrast to the dose-response relationship for lung cancer, the dose-response relationship for intestinal cancer refers to the incidence and not to fatality of cancer. In this study,

15 In these figures of EU-27, Croatia is not yet included. Due to the use of relative rates for calculation they cannot directly be aggregated to EU-28.Therefore, the EU-27 parameter is used.

data on cancer incidence, not cancer mortality have been taken into account for the estimation of the dose-response relationship. Therefore, the total WTP that will be used for the monetisation of health impacts related to intestinal cancer is calculated as presented in Table 3.

Table 3: Monetary values for fatal and non-fatal intestinal cancer risks, based on Alberini and Ščasný (6)

Adding the shares of non-fatal intestinal cancer cases and fatal intestinal cancer cases to get the total WTP per case of intestinal cancer	
Probability of intestinal cancer ending fatal (EU-27 average)	39.7%
→ 2017 WTP value for fatal intestinal cancer cases	**EUR 2,240,065** [0.397 × (EUR 5,228,392 + EUR 414,089)]
→ 2017 Total WTP for one statistical non-fatal/fatal intestinal cancer case	**EUR 2,489,760** (=EUR 2,240,065 + 0.603 × EUR 414,089)

MvE local

Individual ELR lung cancer (local):

$$ELR = \frac{review\ period\ [years]}{70\ years} \times 2.9\text{E-}02 \text{ per } \frac{\mu\text{g Cr(VI)}}{\text{m}^3} \times \text{ MvE local inhalation}$$

Individual ELR intestinal cancer (local):

$$ELR = \frac{review\ period\ [years]}{70\ years} \times 8.0\text{E-}04 \text{ per } \frac{\mu\text{g Cr(VI)}}{\text{kg bw/day}} \times \text{ MvE local oral}$$

where MvE local represents the predicted local environmental Cr(VI) concentration taken from the ES in the CSR.

Total ELR

For the calculation of the total ELR related to MvE local, the total number of potentially indirectly exposed people is assessed taking into account the foreseen population of 10,000 as described in the following formula:

$$Number\ of\ potentially\ exposed\ people\ = number\ of\ sites\ \times\ 10{,}000$$

The calculation of the total excess risk follows the methodology described in Section 6.2.1 according to the following equation:

ELR lung cancer (local):

$$ELR = \frac{review\ period\ [years]}{70\ years} \times 2.9\text{E-}02 \text{ per } \frac{\mu\text{g Cr(VI)}}{\text{m}^3} \times \text{ MvE local inhalation} \times \text{number of people potentially exposed}$$

ELR intestinal cancer (local):

$$ELR = \frac{review\ period\ [years]}{70\ years} \times 8.0\text{E-}04 \text{ per } \frac{\mu\text{g Cr(VI)}}{\text{kg bw/day}} \times \text{ MvE local oral} \times \text{number of people potentially exposed}$$

Monetisation of total ELR

In the next step, the monetised values for additional lung cancer cases are calculated by multiplication with the total WTP value for fatal and non-fatal cancers adjusted to the year of the sunset date (see Section 6.2.1).

MvE regional

The calculations for the ELR related to MvE regional are equivalent to the calculations related to MvE local only using the regional predicted environmental Cr(VI) concentration (MvE regional) from the ES in the CSR and a different number of potentially exposed people as described above.

6.2.3 Worst-case approach of the quantitative assessment

The overall calculation approach entails an overestimation of health impacts for the following reasons:

- The exposure estimates presented by the CSR are already worst-case assumptions regarding frequency of activities as not the average frequency reported for all sites has been used as a basis for the assessment but the highest frequency indicated (see CSR for more details).
- Applicants have been asked to provide worst-case estimations for number of exposed workers. This means that for example workers not really regularly involved in relevant activities have nevertheless been counted in case there is a theoretical possibility that these workers enter respective areas or participate in activities on an irregular basis.
- The assumption of a local population of 10,000 per site assumes each site will be located independently and next to a village or town. In general, most of the sites are located in areas designated for industrial use, often remote from residential areas. The overall potentially exposed population is therefore likely to be substantially over-estimated. Taking into account that the PEClocal air represents the concentration 100 m from the point source (considered to represent the average distance between the release source and the border of

the industrial site), it is clear that in reality it is impossible that 10,000 inhabitants are exposed to concentrations calculated for PEClocal air at the boundary of each site at which Cr(VI) is used. It can reasonably be inferred that the majority of the population is located much more than 100 m from the point source. Therefore, the majority of the 10,000 people is exposed to concentrations much lower than the estimated concentration 100 m from the point source. This is because the concentration of Cr(VI) is decreasing with increasing distance from the emission source. However, for the calculations in the SEA all of these people have been assumed to be exposed at exposure rates as predicted 100 m from the stack (PEClocal). Differently spoken, all 10,000 people have been assumed to be located only 100m from the emission source, which results in a clear overestimation of impacts.

- Calculating the excess of risk evolving cancer for the general population on basis of the dose-response curve published by ECHA (2) assumes a linear relationship between dose and response, even at low doses (below 0.1 µg/m^3). The ETeSS study (7) which was the basis for the dose-response curve published by ECHA (2) itself recognises that a linear dose response relationship for carcinogenicity of Cr(VI) is not established below 1ug/m^3. The study (7) on behalf of ECHA clearly states that: '[…] the lower the exposure (certainly below 1µg/m3), the more likely it is that the linear [dose-response] relationship overestimates the cancer risk.' The study further states that 'the risk estimates for […] exposures lower than 1 µg Cr(VI)/m^3 might well greatly overestimate the real cancer risks. It is also considered that at progressively lower Cr(VI) air concentrations (from about 0.1 µg/m^3 downwards), cancer risks may be negligible.' The PEClocal 100 m from the point source considered in the CSR/SEA is 7.42E-4 µg/m^3 and therefore approximately 130 times lower than the concentration from where the ETeSS study states that cancer risks may be negligible.

- For the calculation of health impacts for the local population, the respective dose response relationship provided by RAC has been used. This dose response curve is based on the estimation that exposure occurs 365 days a year and 24 h a day. In reality, the local population is not present in the relevant area every day a year for full 24 h. For example, people leave the area for 8 h a day in case their work places are located somewhere else or go on holidays for several days a year. The dose response function has not been corrected and therefore over-estimates risk based on inflated assumptions about exposure frequency and duration.

- On-site workers usually live in the direct neighbourhood or in the surrounding area (200 km x 200 km). Therefore, a double counting appears when calculating health impacts for on-site workers and the general population.

In general, an assessment of man via the environment is a requirement of application for authorisation. The assessment was based on clearly worst-case assumptions in order to avoid criticism that the health impacts are under-estimated. These assumptions were made only for the purpose of this SEA and the outcome of the assessment should not be taken out of context. The methodology applied for the man via environment assessment in this SEA from the beginning aimed at overestimating health impacts and was not designed to result in realistic risk estimates. The goal was to demonstrate that even if unrealistic worst-case health impacts are assumed, already a minor share of the overall benefit of continued use is sufficient to outweigh risks.

6.3. Assessment of economic impacts

To generate a robust data basis for the calculation of socio-economic impacts intensive data collection was done at all applicants for all sites individually. The data for economic impacts are based on clear causal chains for the case of a non-granted authorisation and were confirmed by single applicants. Uncertainties and potential variations are investigated in the sensitivity analysis that comes to the conclusion that the result is stable and defines an underestimation of real impacts to be expected. Economic impacts were calculated on the basis of information provided by applicants and publicly available information regarding the automotive sector.

The economic impacts considered in this SEA for the 3 different NUS are calculated based on

- the investment costs required to implement non-feasible alternatives at all sites of the applicants or relocation costs for all companies;
- the NPV of the added value foregone in the NUS (temporary stop of production for the applicants sites and the OEMs);
- expected increase of production costs with alternative technologies;
- unemployment effects in case of relocation.

It should be mentioned here that it is very unlikely that different NUS are relevant for different sites due to the fact that OEMs need to approve alternative technologies, which requires high efforts in any case. Considering the complexity of the supply chains and the facts described in Section 3.3 it is more likely that all applicants would either implement one of the two most likely non-feasible alternatives or the applicants activities related to chromium trioxide will be relocated or covered by non-EEA competitors. For more detailed information regarding the NUS please refer to Sections 7.2, 7.3 and 7.4.

Given any case where a temporary, partial or complete stop of business activities is forecasted, a useful tool/concept for the assessment of the impacts in the non-use scenario is the calculation of the value added foregone during the period while no productive activity is performed. This would be case when:

- the firm would have to stop production for a limited period of time in order to implement a new production process/equipment;

- the firm would have to shut down part of its facilities because no alternative exists for a specific use of the regarded chemical substance;
- the firm would need to stop production until relocation of the production to a non-EEA country is completed and production can continue at the new site;
- the facilities would have to be completely shut down because there are no alternatives for the substance in none of the processes performed at the facilities or because the facilities cannot survive without an activity that cannot be any longer performed without the regarded chemical substance.

The approach of value added foregone was suggested in the SEAC opinions for different previous applications for authorisation, for example in the application regarding the use of DEHP for the production of PVC articles (12). It is a measure that shows how much value is added by that firm specifically (that specific level in the supply chain) and therefore is calculated by subtracting from the turnover (sales revenues) of the facility/firm, the total cost of components, materials, and services purchased from other firms:

$$\boldsymbol{Added\ value} \\ \boldsymbol{= annual\ turnover} \\ \boldsymbol{- costs\ of\ components, materials\ and\ services\ purchased\ (excl.salaries\ and\ depreciation)}$$

The costs used in the calculation, however, do not include the labour and capital costs, that is, costs with salaries and depreciation, and for this reason, the calculated amounts of value added already include the contribution of workers and capital, related to the productivity of labour and equipment installed.

The value added for the assessment of impacts is calculated considering the period of time that no productive activity would be performed by the applicant, adding no value for the society, and for this reason it is called foregone. Given the availability of annual financial statements, the value added foregone will be calculated as a fraction or multiple of years. In this case, the value added foregone will combine flows happening in different periods in time. In order to combine those economic flows (that happen in different points of time) and allow the comparison with health impacts in the base year (2017), the net present value (NPV) in 2017 of the value added will be calculated.

The NPV is a common methodology applied in economics. It is calculated according to the following equation:

$$NPV\ (i) = \sum_{t=0}^{N} \frac{R_t}{(1+i)^t}$$

where

i is the discount rate

N is the number of years for which the NPV is to be calculated (review period)

R_t is the cash flow / the amount of money in year t (e.g. social impacts)

An inflation rate of 1.5%[16] (geometrical mean of annual price increase rate from 2010-2014) was employed to inflate the 2013 values to the base year (2017). To discount the values from 2018-2037 to 2017 values (base year) a discount factor of 4%[17] was employed.

6.4. Assessment of social impacts (salary cost method)

The primary social impact evaluated during this study is the impact of loss of earnings relating to job losses following relocation by the applicants. Other social impacts are more difficult to quantify and have not been considered in the cost-benefit analysis, but may include:

- foregone productivity of the workers (value-added that would have been generated by the workers);
- secondary and tertiary job losses in the supply chain and at local service providers;
- additional costs for the society due to unemployment;
- impacts of loss of purchasing power;
- loss of competitiveness;
- loss of R&D capacities.

In the course of the data gathering via the questionnaires, the applicants were asked about number of staff employed at sites with chromium trioxide use. As a consequence of the non-use scenario relocation, these jobs would be lost. At the same time, applicants were asked to classify the jobs that would be lost according to their education levels low skilled / high skilled / academic.

Lost employee wages are calculated for the average duration of unemployment in Germany which was 38 weeks in 2014 as besides one site in Spain, two sites in Czech Republic and one site in Slovakia all sites are located in Germany. The average unemployment time in Europe in 2014, was 15.3 months[18]. The applicants have been asked to provide annual salary cost directly related activities depending on use of Cr(VI) and overall salary costs. These salary costs provide a basis for calculation of a measure for social effects due to job losses in case of relocation or shut down.

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16 This inflation rate is used for the entire impact assessment.

17 4% is the default discount rate as presented in the ECHA guidance on SEA

18 Source: https://stats.oecd.org/Index.aspx?DataSetCode=AVD_DUR [2015.01.05].

7. ANALYSIS OF IMPACTS

In the following sections, the expected impacts for the 3 non-use scenarios are described and assessed. Firstly, the human health and environmental impacts related to the applied for use scenario are assessed (see Section 7.1). The subsequent analysis of the socio-economic impacts for each NUS is provided in Sections 7.2, 7.3 and 7.4.

The impact assessment is carried out for a period of 12 years, since this is the minimum necessary review period required (see AoA and Section 5). Details regarding the applied methodology have been described in Section 6.3.

7.1. Human health and environmental impacts for the applied for use scenario

As stated in Section 6.2 in accordance with the corresponding CSR (9) the risk assessment for workers exposed in this SEA is restricted to inhalation of airborne residues of chromium trioxide (lung cancer). For the general population, inhalation exposure to Cr(VI) and oral exposure to Cr(VI) via the food chain is also taken into account. Oral exposure via the food chain leads to an additional risk of intestinal cancer. The rationale for limiting the risk assessment for workers exposed in this SEA to inhalation of airborne residues of chromium trioxide is as follows:

(i) available information on potential exposure (airborne concentrations) does not provide reliable detail regarding particle size fractions (inhalable / thoracic / respirable);

(ii) the Excess Lifetime Risk (ELR) for intestinal cancer is one order of magnitude lower than that for lung cancer; the assessment of health impacts is therefore dominated by the risk of lung cancer due to inhalation of chromium trioxide dust;

(iii) the document on a reference dose-response relationship for Cr(VI) compounds (RAC/27/2013/06 Rev.1) states that ‘in cases where the applicant only provides data for the exposure to the inhalable particulate fraction, as a default, it will be assumed that all particles were in the respirable size range’.

Therefore, in accordance with the above findings and provisions, it has to be assumed that all particles are in the respirable size range hence no exposure via the oral route needs to be considered for workers. This constitutes a worst-case approach, since the lung cancer risk, is an order of magnitude higher compared to the gastrointestinal cancer risk, based on the dose-response relationships.

The assessment of human health impacts considers workers potentially exposed at facilities of the applicants and the general population.

The analysis is based on gathered data from applicants and assumptions in accordance with ECHA guidance regarding the number of workers and the members of the general population respectively that are *potentially* exposed.

The number of potentially exposed workers (industrial) has been assessed to account for exposure at the 22 sites of the applicants. Upper bound exposure concentrations are based on measured and modelled data as set out in the CSR.

Table 4 below shows the monetised health impacts, derived in accordance with ECHA guidance, for workers potentially exposed to chromium trioxide during PoPAA at the applicants sites.

Table 4: Summary of monetised health impacts for potentially exposed workers considering the applicants' 22 sites

	[EUR million]
Total	**5.050**

Exposure to the public has been estimated based on conservative assumptions regarding airborne releases from facilities and a substantial population consistent with a small town (10,000 population) at the site boundary (PEC_{local}) and the regional population of 200,000,000 in the area where sites are located ($PEC_{regional}$).

Table 5 below sets out the monetised health impacts, derived in accordance with ECHA guidance, for members of the general population exposed to chromium trioxide and potentially indirectly exposed workers to chromium trioxide as a result of PoPAA by the applicants. The analysis is based on a review period of 12 years.

Table 5: Summary of monetised health impacts in the general population considering the applicants' 22 sites

	[EUR million]
MvE_{local}	4.540
$MvE_{regional}$	0.021
Total	**4.561**

An assessment of the sensitivity of key assumptions is provided in Section 8. Further details for the calculation of the values provided above are given in ANNEX A.

A report by the Institute of Occupational Medicine (2011) concluded there are no significant environmental impacts foreseen related to Cr(VI) (13). Indeed, under normal environmental conditions, Cr(VI) will not persist, but be transformed to Cr(III), which has limited if any effects on the environment. As Cr(VI) can be effectively captured in filters or treated in wastewater treatment plants, emissions to air and water from current surface treatment operations are very limited.

7.2. NUS 1: Substitution by non-feasible alternative Cr(III)

This section summarises the expected socio-economic impacts for the NUS assuming complete substitution of chromium trioxide by implementation of Cr(III). As previously mentioned, this is a hypothetical scenario as according to today's R&D status, use of Cr(III) to completely substitute chromium trioxide in PoPAA is technically not possible, since, besides quality and colour variations, a Cr(VI)-free etching procedure is not yet available for serial production. Figure 8 illustrates the economic impacts that are considered in this NUS.

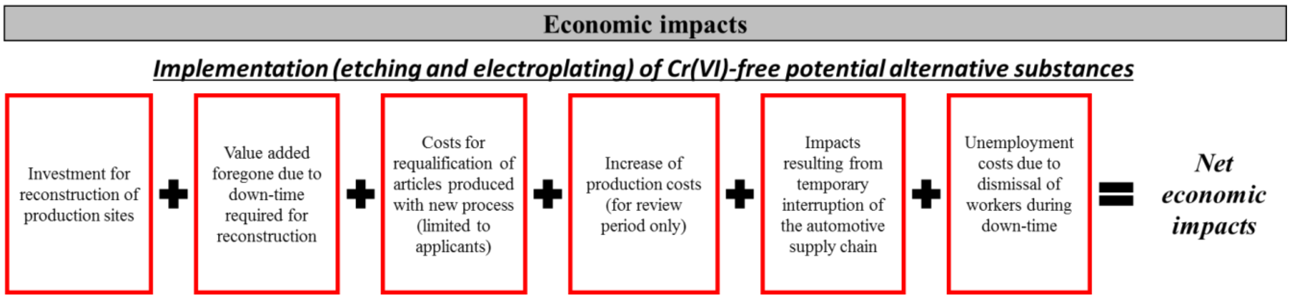


Figure 8: Net economic impacts considered in the NUS 1.

The applicants have been asked to provide information on steps required to implement Cr(III) in their sites individually for each site. Furthermore indications regarding required time frames for implementation of the respective steps have been collected. Based on the applicants' information, the following overview summarising the minimum efforts necessary for implementation of Cr(III) has been prepared. At some sites additional steps are required and more time would be needed for implementation due to the site-specific conditions. These additional site-specific steps have not been taken into account for the assessment to guarantee that the assessment of impacts is based on a best case estimate.

Figure 10 shows the necessary steps for the substitution of chromium trioxide by Cr(III). Initially, the step project planning has to be mentioned. It takes at least **Blank 1** and includes chemical aspects (e. g. selection of starting materials and suppliers, availability, safety aspects and storage of chemicals, disposal of Cr(VI) electrolyte), procedural aspects (e. g. planning of process flows, ordering of required additional equipment, expansion of analytical capacities) and constructional aspects (e. g. building expansions, additional infrastructure). As a next step the application of official permissions regarding a possible reconstruction of the production building, which takes at least **Blank 1**, is required. At the same time official permissions for the actual start of the production of the modified process can be requested. A reconstruction of the production building comes in most cases along with this NUS (at least **Blank 1**), since, due to the much higher sensitivity of the Cr(III) based plating process towards impurities, more process steps are involved and thus more space is required (elongation of production line up to 10 meters, Figure 9).

Blank 1

Figure 9: Impact of process change to Cr(III) alternatives on the dimensions of the production building.

Additional rinsing baths both for the pre-treatment and the actual plating step, which have to guarantee a quantitative separation of metal traces significantly influencing the quality and appearance of the final Cr layer, have to be implemented in the process. Furthermore, an additional passivation step of the deposited Cr coating including expensive anodes demands further space and has to be mentioned. In this context, a higher space requirement for additional analytical studies for the correct adjustment of critical process parameters (e.g. bath acidity), such as concentrations of complexing and buffering agents, can be noted as well. During the reconstruction of the production building modification of the production plants can be initiated, which has to be done in any case step-by-step due to capacity constraints of suppliers. Besides the installation of additional baths the wastewater system, which has to guarantee in addition to a quantitative removal of heavy metals (e. g. by precipitation, electrolytic purification, ion exchangers or adsorption) a monitoring of new process-related parameters, has to be reconstructed. It has to be highlighted that an additional wastewater strand is necessary, since potential etching solutions are not compatible to Cr(III) electrolytes. The time period of the trial phase of the modified process takes at least **Blank 1**. It requires an earlier authority permission for the process start and involves the aspects preparation of chemicals, the proper implementation of new rinsing and etching procedures and the adjustment of optimal process parameters, such as the temperature of the Cr(III) electrolyte, the adjustment of bath acidities and the manually regulated additive concentrations. Costs for this step are particularly generated by the required chemicals for test runs and additional workers. The final qualification of the manufactured components both by the applicants themselves and clients takes at least **Blank 1**, depending on the number of different components, on the OEM's requirements and whether an arrangement in groups of components is possible and accepted. Thus, a serial production for this NUS can be achieved in the best case after **Blank 1**.

Blank 1

Figure 10: Minimal amount of necessary steps and time needed for the complete implementation of NUS 1. Brighter colour shades indicate that single steps could take significantly longer, respectively.

7.2.1 Investment costs for the implementation of NUS 1

In general it has to be emphasised that no mature technical solution is available for a Cr(VI) free electrolytic etching concerning the overall optic result, selectivity and general handling. The implementation of a Cr(III) based procedure entails the need for new equipment. In this context, a higher number of baths, racks, tanks and further steel constructions has to be mentioned, since the overall technology is more complex resulting in more individual production steps. In order to remove accumulating traces of metals, such as Fe, Ni and Cu, which would influence the quality and appearance of the final Cr layer, ion exchangers have to be integrated in the process. Hence, a regular exchange of the special resin is implied as well. Moreover, the Cr(III) based method requires different types of Ti-based anodes for the electrochemical deposition of elemental Cr in order to avoid the decomposition of the electrolyte, which are significantly more expensive (~EUR **Blank 1**, depending on the size of the site) and considerably more fragile leading to regular exchanges each 1.5-2 years (14).

According to Table 6, when always considering the average amount of costs for each step given by the applicants, at least EUR **Blank** + EUR **Blank 1**, see Section 7.2.2) per site have to be invested for the implementation of a Cr(III) based method. In total, considering 22 sites of the applicants, EUR **Blank 1** have to be invested when changing to a Cr(III) procedure.

Table 6: Required steps and time and cost ranges for the implementation of NUS 1. Depending on the size of the site the respective data may vary significantly, which is considered for the determination of the average costs

Blank 1

7.2.2 Costs for re-qualification

In general, the qualification of components might include the following steps. Firstly, the respective production parameters have to be optimised and adjusted. In a second step, different sample trials and an internal sample inspection takes place followed by internal laboratory tests. The achieved information and improvement possibilities are then implemented in the process, which is a prerequisite for an external inspection of processed components by the clients. Finally, the gained results are summarised in an initial sample report. These procedures take, depending on the number of components, their complexity and the capacity of the client, at least **Blank 1**. This time range is significantly prolonged in case long-term studies are involved. A possible generation of product groups would in theory facilitate the whole procedure, which, however, has to be approved by the OEMs. ANNEX B gives an insight of different tests required for the qualification of components.

The costs for the re-qualification per site are calculated by dividing the sum of all produced types of articles of all applicants (10,000) by the number of sites of the applicants (22) times the average qualification costs per article (EUR **Blank 1**). The resulting value is EUR **Blank 1** per site and assumed to be identic for all NUSs.

7.2.3 Loss of value added due to down-time

Another factor that adds to the economic impacts in case of non-authorisation is the production downtime caused by the implementation of alternative technologies. The downtime to be considered depends on the date the decision not to grant an authorisation will be communicated to the applicants. In case this information would be provided by the European Commission before the sunset date, some of the required steps for implementation of Cr(III) could start while production would continue until the sunset date (e.g. project planning). In case the decision would be communicated after the sunset date, the production would have to be stopped immediately and at the same moment the activities required to setup a Cr(III) would start. As everything else is highly speculative and for simplification reasons, it is assumed that the decision not to grant an authorisation will be communicated to the applicants at the sunset date. The applicants expect that on average the complete implementation process of the new technology until full production capacity and qualification of all articles is obtained would take in a best case approximately **Blank 1**. This time refers to the whole implementation and its different steps described in Section 7.2.

Meanwhile the new plating technology is implemented, pre-production lines like injection moulding lines for manufacture of plastic parts relying on the plating process will have to be shut down resulting in opportunity cost for the company. The total duration while the production would have to be stopped for deconstruction of the existing electroplating systems and setup of Cr(III) is estimated by the applicants to take at least **Blank 1**. This is the minimal amount of time needed to start the production without a full qualification of all components. It is a best case approach and considers that the production runs up gradually and components can be partly manufactured and sold to the OEMs without a complete qualification of the whole portfolio. For bigger sites even a longer period of time might be required. The existing plants are planned to be running at full capacity and continuously, not being able to replace the electroplating system without a production stop. Furthermore, as previously explained, stock building is not possible and also maintenance intervals cannot be used for reconstruction as maintenance periods at the applicants' sites are limited to **Blank 1** maximum. The calculation of the opportunity cost during this period (**Blank 1** were assumed) was done using a metric suggested by members of SEAC in previous AfAs: *the added value foregone*. In order to calculate the added value foregone, the costs of inputs (except capital and labour) are subtracted from the turnover (net sales).

$$added\ value\ foregone = turnover\ (net\ sales) - costs\ of\ inputs\ (except\ capital\ \&\ labour)$$

For the calculation of the added value foregone it is necessary to consider the expected development of the company's turnover in the upcoming years. Even though the market on chromium plated plastic parts is expected to grow (see Section 3), for the assessment of economic impacts it will be assumed that the turnover would be constant in real terms during the assessment period. This is to avoid overestimation of economic impacts.

Added value foregone

In 2014, the turnover of the 22 sites of the applicants related to the production of chrome plated plastic parts reached EUR **Blank 1** while the correlated production costs (excluding labour and capital costs) amounted up to EUR **Blank 1**. Therefore, the annual amount of added value reaches EUR **Blank 1**. Considering that in real terms this amount would keep at least constant and that the production at all 22 sites would have to be shut down for a period of **Blank 1**, the impact of the downtime due to the implementation of the alternative is calculated below in Table 7 and Figure 11.

Table 7: Added value foregone with downtime in 2014 price levels

Blank 1

Blank 1

Figure 11: Calculation of value added foregone due to down-time.

7.2.4 Loss of profit due to higher manufacturing costs and increased scrap rate

In addition to the general steps shown in Figure 10, other problems generation further costs during the production might come along with the implementation of NUS 1 (Table 8). The energy costs will certainly increase when changing to a Cr(VI) free method. This can be explained by higher current density necessary for the dispersion of the metal layer resulting in higher bath temperatures. As a consequence the respective bathes have to be cooled in order to guarantee the right operating temperature. The fact that a higher current density is needed for the Cr(III) plating process leads to a higher amount of electrolysed water (H_2 and O_2 has to be removed by exhaust ventilation). Moreover, more side products are formed during the Cr(III) procedure and in total more chemicals are involved in the entire process (complexing and buffering agents), which leads to a significant higher amount of chemicals (Figure 12) (14).

Figure 12: Additional chemicals needed for the Cr(III) based electroplating process (BIA Kunststoff- und Galvanotechnik GmbH & Co. KG, 2015).

It should furthermore be emphasised that the mostly sulfate or chloride based Cr(III) electrolytes are significantly more expensive compared to Cr(VI) electrolytes. Higher costs and shorter time intervals are also expected concerning maintenance aspects, since the whole process technology is more complex (more baths required, ion exchangers, prone electrodes, sensitive process parameters) and the fact that the aggressive Cr(III) electrolyte could attack welding seams of the baths. In addition, analytical tests are getting more complicated and thus might not be performed in-house anymore. More investments also have to be considered for the workers, which is a consequence of the need of occupational re-training and additional process steps, such as manual regulation of additive additions not required for Cr(VI) electrolytes. Another important aspect is the need of a higher amount of daily quality tests, which implements higher personnel costs. Due to process-related variations of layer thicknesses and hues in the case of a Cr(III)-based method, more attention has to be particularly paid to quality aspects, which additionally leads to higher scrap rates (~**Blank 1** after process start, more than **Blank 1** after complete implementation) causing further costs (14).

Note that the given cost trends in Table 8 are estimates for the future after the complete implementation of NUS 1 due to gained experience and general developments of prices (for example energy costs). Furthermore it has to be mentioned that the content of Table 8 is based on real experiences gained at sites of one applicant, who has already gained experience in Cr(III) plating process.

Table 8: Aspects influencing process costs for the implementation of NUS 1 compared to Cr(VI) and estimated cost trends during the review period

Blank 1

As already explained, due to the price sensitivity of the market and competition from non-EEA countries, the applicants will not be able to forward increased production costs to their clients by higher prices (which usually anyways are fixed by long-term contracts).

Based on the applicants' annual production costs correlated to Cr(VI) activities (excluding labour and capital costs) of EUR **Blank 1** and annual salary costs correlated with Cr(VI) activities of EUR **Blank 1** total annual production costs correlated with Cr(VI) activities for the applicants in 2014 have been EUR **Blank 1**. An increase of production costs of **Blank 1** due to the change to Cr(III) based electroplating is estimated by the clients for the first 3 years. As a consequence of gained experience concerning procedural aspects, such as correct use and dosing of chemicals leading gradually to less scrap rates and increasing routine of workers, the additional costs are reduced to **Blank 1** and **Blank 1** for the years 4-6 and 7-12, respectively. This procedure is considered, since an overestimation of additional production costs is supposed to be avoided. The NPV for losses due to increased production costs sums up to EUR **Blank 1** (see Figure 13).

[redacted]

Blank 1

Figure 13: Calculation of losses due to increased production costs.

7.2.5 Impacts on the supply chain

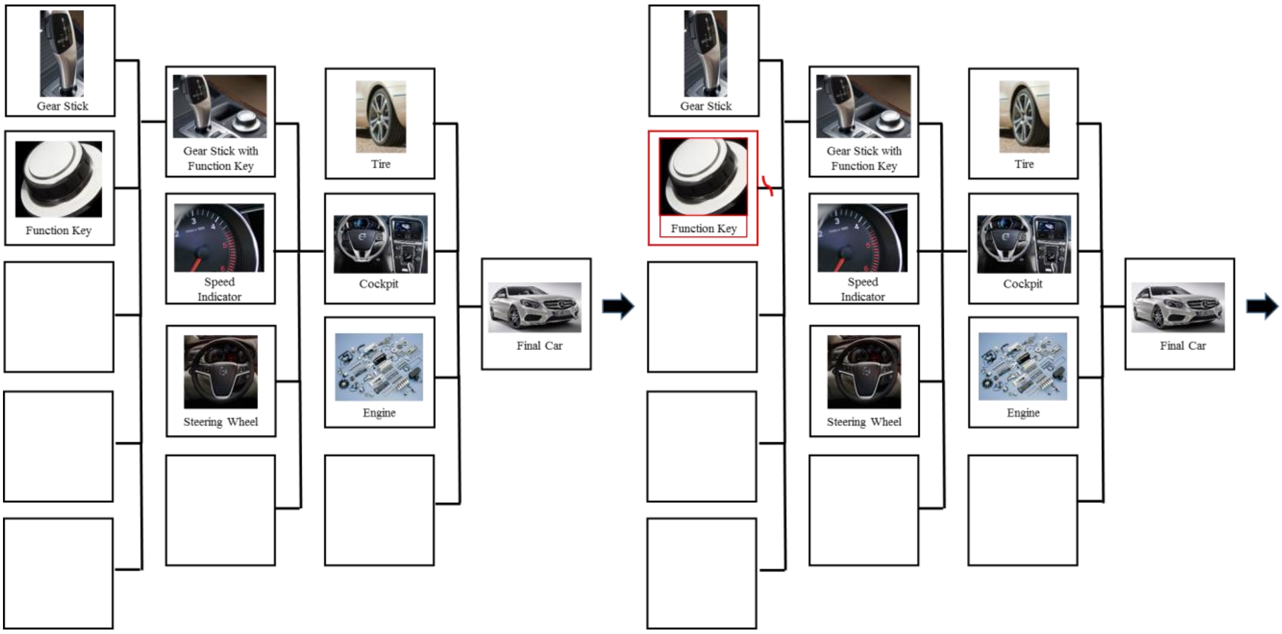
The importance of the European automotive industry for the European society has already been described in Section 3.4 of the SEA. PoPAA is used by the applicants to produce interior and exterior parts for motor vehicles (e.g. trucks, cars and motorcycles) such as grilles, handle, logo and emblems, covers and shielding, console decorations, airbag badge, decorative strips, rings, knobs, rotary elements etc.

Today, chrome plated plastic parts are commonly used in cars to meet the demands on design and haptic of the surfaces and to reduce the overall weight of the vehicles (to finally achieve fuel savings and better emission values). Consequently, chrome plated plastic parts are of high importance for the automotive manufacturers.

Many suppliers of the OEMs, like the applicants, are already involved in the design and conception of the parts (which starts usually more than 5-7 years before start of production). These companies provide not only chrome plating on plastic parts, they also produce the parts (by injection moulding) and provide the final assembly of components. The plating process itself is only one important step in the overall value chain, the associated processes demand a much higher labour force. It is important to mention that chrome plated plastic parts are in many cases not directly sold to OEMs but delivered to further EU companies which are specialised for manufacture of components like for example steering wheels. More information about the automotive supply chain has already been provided in Section 3.3

In case of a non-authorisation the applicants would have to shut down their electroplating facilities until alternative technologies have been implemented (NUS 1 and 2) or relocate their chromium trioxide related production lines to non-EEA territory (this step is even easier for companies that already have non-EEA production sites). This results in a temporary down-time of at least several months.

Due to just-in-time supply widely used in the automotive industry, very shortly after stop of production by the applicants, a complete interruption of the automotive supply chain will result as a consequence that European suppliers are not able to deliver chrome plated parts anymore. Figure 14 illustrates the subsequent impacts in case one article of the supply chain cannot be offered anymore.



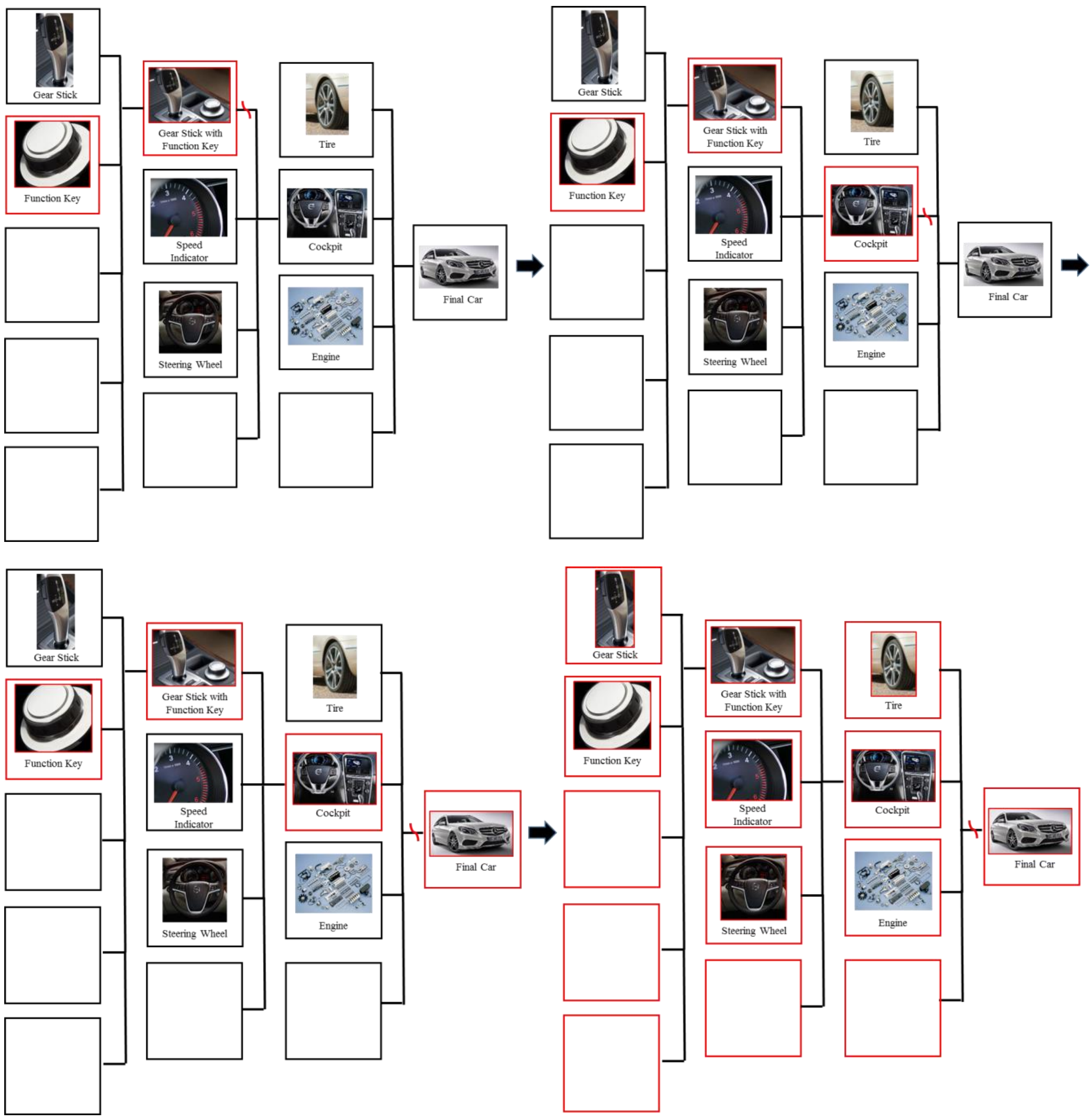


Figure 14: Simplified supply chain of parts for car manufacture and consequences of non-delivery of components (Picture of engine: HubPages, undated).

According to information from the applicants, European manufacturers of PoPAA parts - due to the increased demand during the last years - already operate their sites with full capacity. Even if a decision is known some months before the sunset date, stock piling is therefore not possible as the complete production capacity of the applicants is required to satisfy the actual demand of OEMs. Furthermore, the applicants production follows the just-in time principle and consequently only very limited warehouse capacities are available at the applicants' sites. Furthermore, chrome treated plastic parts have to be packed in standardised special containers, which allow safe delivery to clients and efficient follow-up use in the production process of clients. The standardised boxes (examples see Figure 15) used to pack parts consequently circulate between the applicants' sites and customers. To build relevant stock volumes, expensive containers/boxes would have to be bought first. Considering the high number of parts produced by the applicants per day, it is obvious that stock piling for a longer period than a few days is impossible.

Figure 15: Examples of special containers for chrome treated plastic parts (Fischer GmbH & Co. surface technologies KG, 2016).

Building safety stocks to compensate interruption of production for a relevant time period is therefore not possible. Building up a new non-EEA site or installation of alternative technologies between the date the decision not to grant an authorisation is communicated and the sunset-date is also impossible due to massive investment costs, production time for special equipment/machines and time required to get the necessary permits (companies could perhaps already start planning of relocation or reconstruction of sites).

Although it is unclear today how the different companies will react, it is clear that lost EU production of chrome plated parts, which occurs at least for a limited time frame required by the applicants to implement alternatives or relocate their production sites, would need to be compensated by imports from non-EEA countries to avoid that OEMs' production would be interrupted for a longer time period. In any case, it will take some time until sufficient production capacity to compensate production loss in the EEA will be created in non-EEA countries. Furthermore, to prevent failures of end products resulting in costly product recalls, the automotive industry has rigorous testing and validation procedures in place and new non-EEA suppliers need to be qualified.

Regarding the OEMs it is therefore very unlikely that the supply gap for chrome treated plastic parts can be closed immediately after stop of production by the applicants. Consequently, the lack of availability of chrome plated parts would affect vehicle production volumes, which, when considering the economic importance of the automotive industry to the European economy, could have widespread negative effects. Besides a time-limited interruption of the own production, the consequences for the automotive manufacturers will first of all be that supply by the just-in-time principle will not be possible for components containing chrome plated plastic parts anymore. Due to the required long-range transport of parts from non-EEA countries to the EEA which is correlated with higher risk for delays, article manufacturers / assemblers / automotive manufacturers will need to increase their storage capacities leading to higher storage costs. Furthermore, increased logistic costs (transportation costs) have to be expected. The price for components including chrome plated parts and components including these parts can be expected to grow at least during the first years after the sunset date as supplies need to compensate relocation costs and costs for increase of production capacities in non-EEA countries. Non-EEA suppliers will recognize that European OEMs depend on their products and consequently, due to the limited availability of chrome treated plastic parts on the market, prices will increase. This may result in lower profits for the automotive manufacturers if price increase to compensate higher costs is not possible due to the competition from non-EEA automotive manufacturers or consumers not accepting higher car prices in Europe.

It should be mentioned here, that it is questionable whether current customers would return back to the applicants after they have relocated their supply chain to non-EEA countries during the time required by the applicants to implement new technologies. Why should OEMs or automotive suppliers performing sub-assembly steps using the applicants parts turn back to European producers after having qualified non-EEA suppliers for chrome plated plastic parts? Requalification of every new production line installed by the applicants resulting in effort and costs for OEMs would be necessary.

In the following, a best-case estimation for the economic consequences for automotive manufacturers resulting from a supply chain interruption is given.

According to the latest Economic and Market Report[19] published in September 2015 by ACEA (European Automobile Manufacturers Association) EU passenger car production is growing, with 8.3 million units produced in the first half of 2015. This is an increase (+5.8%) compared to the same period in 2014. Furthermore, European commercial vehicle production is expected to remain stable at around 2.9 million units in 2015. Overall, in 2014 the EU produced 17.2 million motor vehicles, (19% of the 90.6 million produced globally). Assuming 365 days production per year, this means that based on 2014 production volumes at least 47,000 motor vehicles have been produced per day in the EU or 1.4 million motor vehicles per month. It can furthermore be reasonably assumed that every motor vehicle produced contains several parts delivered by an EU supplier.

19 http://www.acea.be/statistics/article/economic-and-market-report-quarter-2-2015 [2015/10/07]

As mentioned above, non-authorisation will result in interruption of the supply chain until the demand can be satisfied by non-EEA production. The applicants cover a market share of approximately 80 – 90% in Germany and 35 – > 50% in Europe. In a very optimistic scenario, it can be assumed that 10% of the lost EU production volume of PoPAA parts covered by the applicants can be compensated by non-EEA supply immediately after the sunset-date. It is furthermore estimated that per additional month non-EU production capacity equal to 10 % of the applicants' capacity will be created (in reality this will hardly be possible as qualification of products produced with new production lines built in non-EEA countries will take more time). The assumptions above are clearly a best case estimation as independently of the time the decision of the European Commission is published, sufficient production capacities to manufacture more than **Blank 1** chrome treated plastic parts (more than 10,000 different articles) per year need to be created in non-EEA countries after the sunset date.

Assuming that only the applicants would be affected by non-granted authorisations (which is considered unrealistic) the consequence will be 31.5% loss of the European motor vehicle production during the first month after the sunset-date (35% market share of the applicants * 0.9 as 10% market share can immediately be covered by non-EEA suppliers), 28% loss during the second month and full production after 10 months. Overall, based on 1.4 million vehicles produced per month and a market share of 35% only, this would result in a loss of production of 2.205 million motor vehicles due to interruption of the supply chain resulting from a non-granted authorisation (see Table 9).

Table 9: Calculation on loss of production volumes for OEMs due to a non-granted authorisation

Month after sunset-date	1	2	3	4	5	6	7	8	9	Sum
Market share of applicants	0.35									
Reduction of vehicle production due to interruption of supply chain	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	4.5
Reduction factor taking into account market share	0.315	0.28	0.245	0.21	0.175	0.14	0.105	0.07	0.035	1.575
Number of vehicles not produced per month due to interruption of supply chain	441,000	392,000	343,000	294,000	245,000	196,000	147,000	98,000	49,000	2,205,000

In 2013, the Center for Automotive Research (CAR)-Institute of the University Duisburg-Essen headed by Professor Ferdinand Dudenhöffer has evaluated profitability of automotive manufacturers[20] [21] [22]. The group of scientists calculated earnings before interest and taxes (EBIT) exclusively for the automotive sector of the companies between January and June 2013. Supply activities or other fields of business like maintenance and service, financial and monetary services and real estate business have not been taken into account. The following Table 10 shows the results for some European OEMs published in different newspapers.

Table 10: EBIT-automotive sector firms

Company	**EBIT per sold car in EUR**	**EBIT margin in per cent**
Renault	-457	-3.1
Peugeot-Citroen	-349	-3.9
Seat	-164	-1.1
Fiat	-130	-1
VW	629	3
Skoda	671	4.9
Mercedes	2,012	4.9
BMW	3,495	9.8
Audi	3,821	10.5
Ferrari-Maserati	15,000	11.9
Porsche	1,6590	18.4
Average[23]	**2,557**	**5**

Based on this overview, as a conservative estimation, an EBIT per manufactured car of EUR 1,000 can be assumed for the time after the sunset date (the EBIT per sold truck and bus not further considered here is expected to be higher than EUR 1,000). This means that the **overall loss of EBIT** for automotive manufacturers alone due to loss of production as described above would sum up to at least **EUR 2.2 billion.**

[20] http://www.manager-magazin.de/unternehmen/autoindustrie/a-850747.html [2015/10/07]

[21] http://www.handelsblatt.com/auto/nachrichten/gewinn-pro-auto-porsche-zeigt-wo-der-hammer-haengt/8032740.html [2015/10/07]

[22] http://www.welt.de/wirtschaft/article118779825/So-viel-verdienen-die-Autohersteller-pro-Fahrzeug.html [2015/10/07]

[23] The average EBIT is not used for calculation as it does not reflect the number of cars sold by the respective companies.

According to the ACEA Pocket Guide 2014-2015[24], in 2011 the automotive industry in total contributed to the overall value added in the EU 27 with EUR 154.3 billion. Assuming the decreased motor vehicle production volumes resulting from the supply chain interruption described above and considering that the same consequences would occur for the whole supply chain, as very conservative assumption at least 12.9%[25] loss of production in the whole supply chain can be expected for the year after the sunset date (assuming that full production by OEMs will be possible after 10 months). Reduced production by OEMs results in similar reduction of demand for all parts required to manufacture cars (e.g. tyres, steel, car windows), and therefore equal reduction of production at all suppliers down the supply chain. Assuming that the value added is directly correlated with the production output of the automotive industry, based on the figures for the value added in 2011, a non-granted authorisation would result at least in a **loss of value added of EUR 19.9 billion** for the European society. Taking into account that this figure is based on 2011 data (todays value added is higher as production volumes have increased since 2011) and considering the fact that only 12.9% loss of the 2015 production (the number of motor vehicles produced in 2017 can be expected to be higher) this figure is likely to be underestimated.

As mentioned above, it is clear that a time limited stop of manufacture of motor vehicles by the European OEMs due to interruption of the supply chain for chrome treated parts equally concerns the whole supply industry. The consultants Berylls Strategy Advisors[26] [27] recently published information on the economic situation of the top 100 automotive suppliers worldwide. In 2014, the turnover of the European automotive suppliers summed up to EUR 267.7 billion (German companies EUR 154.8 billion). The average EBIT rate for European companies was 8.7% (Germany 9% and global average 8.1%).

24 http://www.acea.be/publications/article/acea-pocket-guide [2015/10/08]

25 Lost production of 2.2 million motor vehicles after the sunset date as shown in Table 9 represents 12.9% of an annual production volume of 17.4 million motor vehicles.

26 http://www.automobil-industrie.vogel.de/die-top-100-automobilzulieferer-des-jahres-2013-a-442334/ [2015/10/08]

27 http://www.berylls.com/de/informationen/downloads.php [2015/10/08]

The following assumptions are made to calculate impacts of a non-granted authorisation:

- Less than 50% of the business of European automotive suppliers is related to aftermarket activities.
- European automotive suppliers deliver 50% of the manufactured parts to European OEMs (50% export to non-EEA countries is assumed, which is as overestimation resulting in underestimation of impacts).
- A loss of 0.13 production years (1.575 production months according to Table 9) at OEMs due to a non-granted authorisation would result in an equal loss of sales of automotive suppliers to OEMs.

The estimated minimum annual turnover of the European automotive suppliers directly correlated with production of motor vehicles by European OEMs is consequently EUR 267.7 billion Euro x 0.5 (excluding aftermarket activities which do not depend on OEMs production) x 0.5 (excluding export to non-EEA countries which also does not depend on OEMs production) = 66.9 billion Euro. Assuming a loss of 0.13 production years (see Table 9) for the year after the sunset date due to a non-granted authorisation, this would result in a loss of turnover of EUR 8.69 billion (2014 data). Based on an average EBIT rate of 8.7% the **loss of EBIT for European automotive suppliers** correlated with a non-granted authorisation could be at least **EUR 756 million.**

It should finally be mentioned that these figures are based on best case estimations and the value added permanently lost in the EEA due to relocation of parts of the automotive supply chain would be significant. It is obvious that the impacts to be expected in case of an interruption of the automotive supply chain by far outweigh the health impacts correlated to the applied for use scenario.

It also has to be taken into account that the automotive sector is a key driver of knowledge and innovation, representing Europe's largest private contributor to R&D, with approximately 41.5 billion Euro invested annually. Relocation of parts of the supply chain to non-EEA countries will definitely result in relocation of related R&D activities and therefore loss of innovation.

Fort the final calculation of the overall impacts per NUS only the lowest figure calculated above will be used. This means that only the loss of EBIT of EUR 756 million for the automotive suppliers will be counted. **This represents a clear underestimation as impacts on OEMs are consequently not considered. In principle the value added lost for the whole automotive industry would be the more suitable figure.** However, following the best case approach for socioeconomic impacts and taking into account uncertainties related to the calculations it was decided to consider only the lower boundary of calculated values.

7.2.6 Social impacts

This section provides an estimation regarding the primary social impact in case of a non-granted authorisation, job losses resulting from either temporary production stops or shutdown of facilities due to relocation. Further social impacts have not been quantified.

The applicants in total employ 5,795 people of different educational level. The majority of workers cannot be further employed during the shutdown period in case of a non-granted authorisation as there are no tasks related to production (like quality control or loading and unloading of jigs). Workers required organising the necessary implementation of alternatives or the relocation of the sites would be kept as well as some administrative staff. As a best case, it can be assumed that only approximately 80% of the employed people would be dismissed and therefore suffer job losses because of a decision not to grant an authorisation.

This estimated number of job losses is conservative as in case of relocation jobs in administration and financial departments are expected to remain in Europe, which is not guaranteed. The actual number of jobs lost in the NUS 3 is expected to be much higher than the figures mentioned in this report as secondary job losses at suppliers and job losses in the supply chain have not been considered.

A further important point to consider regarding social impacts is that workers that lose their job due to temporary closure / relocation will either:

- remain unemployed for a considerable time frame; or
- replace another unemployed person in case of re-employment (workers that lose their job in company A and get a new job in company B prevent other unemployed persons from getting this job). Consequently, the value-added that has been created by the original workplace is not compensated by re-employment of workers in other companies, leaving the macro-economic impacts of the original job loss untouched.

These assumptions are justified on the basis of the non-use scenario as long as there is not full employment in Europe. Full employment has never been the case and is not expected for the length of the review period. The average unemployment rate in the EU was approximately 9%[28] (2001-2013) and the average unemployment time in Germany is 38.1 weeks[29] (data from 2014), in

[28] Source Eurostat. Unemployment rate (2001-2013), code [une_rt_a] [Cited: 9 February 2015].

[29] http://de.statista.com/statistik/daten/studie/2525/umfrage/entwicklung-der-durchschnittlichen-dauer-von-arbeitslosigkeit/ [Cited: 15 January 2016].

Slovakia 29.6 months[30] and in Czech Republic 17.6 months[31]. Most of the applicants' sites are located in Germany and using a best-case estimate, the average unemployment duration of Germany has been applied.

Salary costs paid by the applicants in total in 2014 summed up to EUR **Blank 1**. Assuming 80% loss of jobs as mentioned before and an unemployment time of 38.1 weeks, the correlated social impact would be EUR **Blank 1**.

The total added value foregone due to downtime in the non-use scenario (if an authorisation is not granted) already includes social impacts related to the dismissals of workers that will happen given a temporary shutdown of the respective sites.

Nevertheless, additional costs to society for unemployment given by public intervention costs should be considered hereinafter. Average cost of an unemployed person in Germany count to EUR 10,813 per year (15). The average duration of unemployment in Germany, as mentioned before, is 38.1 weeks. Consequently, unemployment costs are EUR 7,922 per unemployed person, amounting to more than **EUR 36.7 million additional costs to society for unemployment** in total.

Furthermore, the applicants would have to pay compensations in case they have to dismiss employees due to temporary shutdown. In Germany, employers typically have to pay compensations of 50% of the gross monthly wage multiplied with the period of employment in years in case of compulsory redundancy. Assuming an average gross monthly wage of EUR **Blank 1** per employee and an average period of employment of 5 years, the applicants would have to pay compensations of EUR **Blank 1** per dismissed worker. Consequently, in case of non-authorisation the applicants would have to pay **compensations of EUR Blank 1 for dismissal** of 4,636 employees (80%).

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[30] http://de.statista.com/statistik/daten/studie/2525/umfrage/entwicklung-der-durchschnittlichen-dauer-von-arbeitslosigkeit/ [Cited: 15 January 2016].

[31] http://de.statista.com/statistik/daten/studie/2525/umfrage/entwicklung-der-durchschnittlichen-dauer-von-arbeitslosigkeit/ [Cited: 15 January 2016].

7.2.7 Summary of NUS 1

Figure 16 illustrates the required investments needed to implement NUS 1 and gives a comparison to corresponding health impacts.

Blank 1

Figure 16: Costs needed to invest for the implementation of NUS 1 compared to health impacts.

7.3. NUS 2: Substitution by non-feasible alternative PVD

This section summarises the expected socio-economic impacts for the NUS assuming complete substitution of chromium trioxide by implementation of PVD technologies. As previously mentioned, this is a hypothetical scenario as according to today's R&D status, use of PVD to completely substitute chromium trioxide in PoPAA is technically not possible.

It needs to be considered that the applicants have long-term experience with electroplating and all their sites have been optimised in the last years to perform PoPAA. Implementation of a completely new technology like PVD would in principle mean that the applicants would have to establish 'new' sites based on a technology they have no or minor experience with. Staff employed at the applicants sites is experienced in electroplating and educated respectively. Furthermore, all production processes (pre-plating production steps) like injection moulding to produce plastic parts are specifically designed to fit with the electroplating process. All these processes would have to be adapted to the new technology. The applicants' production halls have been designed to house electroplating systems (see Figure 17).

Figure 17: Example of an applicants' production hall designed to house electroplating systems.

Major reconstruction would be required to reorganise the overall production and to provide sufficient space to install the required number of PVD systems.

Another uncertainty is the question how long manufacturers of PVD systems would require to design, produce, deliver and install machines and technology necessary to cover a production volume of > **Blank 1** parts per year and > 10,000 different articles in overall 22 sites. It has to be taken into account that in case Cr(VI) electroplating for PoPAA would be banned in whole Europe due to not-granted authorisation for that use, not only the applicants but all European manufacturers producing chromium plated plastic parts would need to implement a new technology and rebuild all injection molding tools and in fact demand for PVD systems with production capacities for more than **Blank 1** parts per year (European market share of the applicants > 35%) would be required within months after the sunset date. In addition, manufacturers of other articles like companies from the sanitary sector which today also perform electroplating based on Cr(VI) would potentially also require additional PVD systems to continue their production. Overall, there remains a high uncertainty whether PVD systems are available on the market in sufficient quantity to allow a substitution of Cr(VI) based electroplating for PoPAA in whole Europe.

The information on investment costs provided in this scenario is based on estimations provided by the applicants and responses received from a supplier of PVD systems who was asked to provide quotes for price and timelines for delivery of required PVD systems with sufficient capacity to cover the applicants' annual production. Figure 18 illustrates the economic impacts that are considered in this NUS.

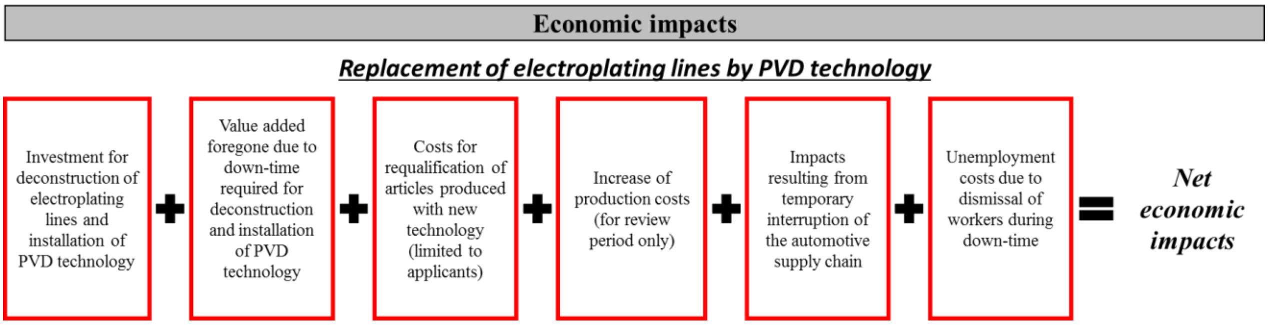

Figure 18: Net economic impacts considered in the NUS 2.

The applicants have been asked to provide information on steps required to implement PVD technology in their sites individually for each site. Furthermore indications regarding required time frames for implementation of the respective steps have been collected. Based on the applicants' information, the following overview summarising the minimum efforts necessary for implementation of PVD has been prepared. Again, at some sites additional steps are required and more time would be needed for implementation due to the site-specific conditions. These additional site specific steps have not been taken into account for the assessment to guarantee that the assessment of impacts is based on a best case estimate.

The following steps shown in Figure 19 illustrate the minimal amount of effort, which has to be considered in this NUS. The step project planning will take at least **Blank 1**. It contains aspects such as planning of the building reconstruction, acquisition and installation of PVD machines, planning of the new building together with architects and cost calculations. As a next step official permissions for the close-down of the old production plants, the reconstruction of the production building with a different use and for the installation of painting lines being implied in the PVD process, have to be requested, which again takes at least **Blank 1**. The subsequent dismantling of the Cr(VI) production plant including disposal of Cr(VI) electrolytes and Cr(VI) contaminated parts is another important issue. The latter implies an extremely high amount of effort due to the fact that special waste has to be disposed adequately under strict safety obligations. Since PVD machines are less effective compared to common electrolytic plating procedures due to the requirement of vacuum chambers and longer coating times depending on layer thicknesses, spinning times and shape of the components, considerably more space is needed in order to guarantee the productivity. It should be further noted that in some cases more PVD machines depending on the shape of the components might be necessary. This leads in many cases to a reconstruction of the production building, since the present production lines are not designed for a completely new technique and a rather simple elongation of production lines is impossible. Furthermore, as a next step, it is necessary to modify a variety of tools and assemblies, for example in correlation with different requests of injection moulding systems, which takes at least Blank 1 due to a high degree of complexity and capacity constraints. The implementation of the PVD process involves a reconstruction/dismounting of the existing wastewater system. Depending whether painting lines are included in the PVD process or not, either modified or no wastewater systems are necessary. The installation and subsequent implementation of the PVD systems including painting lines (if required) can be carried out in a next step. During this time, due to a lack of experience in this field, the operators of plants highly depend on the help of the manufacturers of the PVD systems. Thus, the duration of this step is hard to estimate by the applicants and depends on the manufacturer´s capacities and availabilities, but at least Blank 1 are assumed. It is worth mentioning in this context that the respective process parameters highly depend on the size and geometry of the respective component and thus have to be optimised for each article. Moreover, Blank 1 (see Figure 20), which are required both due to the high amount of different and total numbers of produced articles and used in the plating process for the fixation of components, have to be replaced by special PVD equipment (~EUR Blank 1). Again, the applicants were not able to estimate the time needed for this step due to a high dependence on the manufacturers’ capacities. The implementation of the process takes at least 4 months, since sputtering targets and paints have to be purchased and process parameters need to be optimised during a plurality of test runs, which implies the acquisition of additional workers. The applicants could neither give an estimation for the expected costs nor for the time needed to find adequate workers being able to deal with challenges of the new technique. This can be explained by the fact that almost no specialised knowledge is available in the respective companies and only few experts of this niche technology exist on the market. In a final step, before the serial production begins after at least Blank 1, the qualification of the processed components by applicants and the clients for a time period of at least Blank 1 has to be granted. The ranges of time and costs for this step vary significantly for each applicant due to the different amount of components and quality requirements of the OEMs.

[redacted]

Blank 1

Figure 19: Minimal amount of necessary steps and time needed for the complete implementation of NUS 2. Brighter colour shades indicate that single steps could take significantly longer, respectively.

Figure 20: Storage of frames for fixation of components in the plating process (left: Fischer GmbH & Co. surface technologies KG, 2016; right: BIA Kunststoff- und Galvanotechnik GmbH & Co. KG, 2016).

7.3.1 Investment costs for the implementation of NUS 2

According to Table 11, the costs for the PVD machines together with their installation and start-up steps are in the range EUR Blank 1. Thereby, the prize for coating lines, which are often necessary for the pre- (generation of a smooth surface) and post-processing (optical aspect and protection of metal layer) of the components is included. Further exhaust-air plants need to be implemented, since toxic and volatile chemicals, for example as components in lacquers, are involved in the process and might get in contact with workers during the loading/unloading process. As mentioned in Section 7.3 the modification of required tools (such as injection molding tools) is time consuming and extremely expensive. Values in the range EUR Blank 1 are estimated by the applicants and seem to be justified due to a high degree of custom-made items.

It has to be emphasised that the substitution from Cr(VI) containing methods to the non-feasible alternative PVD implies that a complete rearrangement of the whole process has to be accomplished and that the respective clients have to accept components produced by this technique. Due to additional procedures, such as pre- and post-processing of the components via coating lines, an implementation of this method is problematic. The fact that only little components can be handled due to limited sizes of the PVD vacuum chambers and that variations of quality might occur underlines this assumption. Moreover, the PVD technique does not allow a selective plating of 2K/3K components, which is possible both for Cr(VI)- and Cr(III) based electroplating procedures. When regarding the average effort needed to introduce the non-feasible PVD technique, at least EUR Blank (EUR Blank + EUR Blank 1) per site have to be invested (Table 11). The total sum considering all 22 sites of the applicants would be at least EUR Blank 1 in case the PVD technique should be introduced.

Table 11: Required steps and time and cost ranges for the implementation of NUS 2. Depending on the size of the site the respective data may vary significantly, which is considered for the determination of the average costs

[redacted]

Blank 1

An important part of implementation costs for the potential alternative PVD is the investment necessary to buy and install PVD machines. The number of PVD machines required to replace Cr(VI) based PoPAA at the applicants' sites depends on the capacity of available machines. Investment costs can then be estimated based on costs per machine. Due to experience made with previous AfA and especially as PVD technology providers submitted several comments during public consultations in the past (e.g. CTAC trialogue) the applicants have contacted the company Oerlikon Balzers and asked for information regarding price of PVD machines, capacity of PVD machines, availability with regard to guaranteed delivery times and whether all parts produced by the applicants can be plated with PVD machines taking into account shape and size. However, the applicants so far did not receive any response or information from Oerlikon Balzers.

Against this background, it was only possible to calculate a theoretical number of required PVD machines based on publicly available information and information provided by PVD suppliers Vergason Technology Inc. (SUPERCHROME PVD COATING) and Oerlikon Balzers (ePD Technology) during previous public consultations and trialogues.

The articles produced by the applicants vary significantly regarding shape and size. The number of parts which can be processed per year is therefore not a very robust measure for comparison of capacities of PVD machines and electroplating lines. The maximum surfaces which can be coated within a year is a more reliable figure.

1) SUPERCHROME PVD COATING

Vergason Technology Inc. stated in its comment submitted during public consultation of a previous AfA (16) that with the available batch machines a maximum of 320 pieces of the **ideal dimensions** 100mm x 100mm x 20 mm (3.2 m^2 surface) can be coated one-sided per batch within 18 minutes using planetary rotation. This means that one batch machine has an idealised capacity of 256 m^2/day (24 h operation per day) and 68,352 m2/year (assuming 267 working days, which is the average number of working days per year for the applicants).

2) ePD Technology

Oerlikon Balzers states in a product sheet available on their webpage (17) that **up to** 60 m^2/h can be coated one-sided using a fully integrated and automated INUBIA I12 machine (the bigger machine they produce). Assuming again 24 h operation per day the idealised capacity of one PVD machine is 1,440 m^2/day and 384,480 m^2/year (assuming 267 working days, which is the average number of working days per year for the applicants).

The above figures do not represent the area coated when processing the applicants' parts as the articles manufactured by the applicants have a by far more complex shape and geometry compared to simple plates (see Figure 21). The realistic capacity of PVD machines could not be estimated as such information is not available due to missing experience. Consequently, a comparison of the surface area coated by the applicants per year with idealised capacities of PVD machines would result in an unrealistic picture and unrealistic numbers.

Figure 21: Examples of complex PoPAA parts.

In order to allow comparison of capacities, the idealised capacity of electroplating lines operated by the applicants has been estimated. For all sites where PoPAA is performed, the applicants provided the number of product carriers that can be processed per year and the product carrier window size double-sided in m^2 (please note that product carriers are loaded on both sides as shown in Figure 22).

Figure 22: Example of a product carrier loaded on both sides (BIA Kunststoff- und Galvanotechnik GmbH & Co. KG, 2016).

Multiplying the number of product carriers with the window size, which represents the idealised surface which can be coated per product carrier, delivers the maximal surface area, which could be theoretically coated per year by each site assuming that idealized plates (like assumed by Vergason Technology Inc.) would be processed. Summing up these results for all applicants leads to an ideal surface of **Blank 1** per year. Furthermore it has to be considered that not only the front sides of the articles are coated during the Cr(VI) plating process (which would be represented by the product carrier window size double-sided in m^2) but also the back sides not pointing towards the anodes are coated in a less distinct manner. According to the applicants the magnitude of the backside coating is only **Blank 1** compared to the one on the front side. Thus, not a factor 2 but a factor of **Blank 1** (average of backside coating effectiveness) is applied, which leads to the combined idealised surface area of **Blank 1** for all applicants within one year and which now can be compared to the idealised figures given by Vergason Technology Inc. and Oerlikon Balzers.

In the case of SUPERCHROME PVD COATING (Vergason Technology Inc.) the number of required machines can be calculated as follows:

Blank 1

Vergason Technology Inc. also stated in its comment (16) that a realistic capacity of approximately 12,000 m^2/year can be expected for SUPERCHROME PVD COATING machines. The applicants have also provided figures for the real surface area coated in 2015. Overall, the applicants coated an area of **Blank 1** in their 22 sites in 2015. Compared to the realistic capacity of SUPERCHROME PVD COATING machines more than **Blank 1** would be necessary to replace PoPAA.

According to Vergason Technology Inc. one commercially available PVD machine (model SC660) costs EUR 1-1.5 million. In addition, painting lines, which are necessary in the same amount for the pre-treatment of the substrates before the coating step, costs EUR 1-1.5 million as well (16). Thus, considering the minimal amount of EUR 2 million for a PVD machine including painting line and based on the conservative estimation of **Blank 1** required machines, EUR **Blank 1** have to be invested by the applicants in order to guarantee the current productivity. Vergason Technology Inc. declares that systems can be used six months after the order (16). The current capacity allows the company to produce 30-50 batch machines per year. Thus, at least **Blank 1** would pass for the delivery of over **Blank 1** assuming the maximal producible amount of machines and neglecting capacity and financial limitations as well as orders from other electroplaters, which can be expected to also not get an authorization for their use.

In the case of ePD Technology (Oerlikon Balzers) the number of required machines can be calculated as follows:

Blank 1

In the case of the fully integrated and automated INUBIA I12 PVD machines from Oerlikon Balzers, which comprise one PVD coating line and two painting lines for in total three layers (lacquer/PVD/lacquer) (17), respectively, investment costs per machine of at least EUR 4 million are assumed. The applicants inquired for prices but did not get any response from Oerlikon Balzers why costs of EUR 1 million per painting line similar to SUPERCHROME PVD COATING machines have been assumed and costs of EUR 2 million for the PVD automat). This is expected to be a conservative estimation as Oerlikon Balzers in their comment indicated that an INUBIA I12 PVD machine would cost approximately the same as an electroplating line (electroplating lines are by far more expensive than EUR 4 million). Consequently, at least EUR **Blank 1** have to be spent by the applicants in order to guarantee the present capacity.

In a commercial advertise Oerlikon Balzers furthermore indicates that INUBIA machines allow spindle[32] cycle times of < 45 seconds (17). Based on a spindle time of 45 seconds, 24 h operation per day and 267 working days a year, an average loading per spindle of **Blank 1** parts would have to be achieved to guarantee that 54 INUBIA machines can cover the applicants' production volume of **Blank 1**. Taking into account the shape of parts produced by the applicants, it seems to be questionable whether an average loading of **Blank 1** parts per spindle is possible.

The short-term availability of such a high number of required machines is doubtful. It is claimed by Oerlikon Balzers that the assembling, installation and ramp-up for a single machine takes around 18 months after placing of an order (18). In case of a plurality of simultaneous requests this time estimation might be significantly prolonged, if at all possible.

Taking into account the considerations presented above, it is expected that a mix of batch PVD machines to produce big parts which cannot be processed with automatic PVD lines (spindle length according to Oerlikon Balzer = 1,200 mm = maximum workpiece length (17)) and automatic lines for small parts produced in high quantities would be required by the applicants to cover their production volumes. Overall the figures presented above show that the average costs for implementation of PVD estimated in the NUS (see Table 11) are realistic or even optimistic.

7.3.2 Costs for re-qualification

As stated in Section 7.2.2 it is assumed that the qualification costs are identic for all 3 NUS, since the necessary steps for the qualification do not significantly depend on the process of production. Thus, an amount of EUR **Blank 1** per site is considered for the calculation of investment costs for the implementation of NUS 2 (see Section 7.3.1).

Whether in reality the applicants will be able to provide the identical spectrum of articles after a relocation is unclear as the automotive suppliers and OEMs depending on chrome plated plastic parts manufactured by the applicants will seek to close supply gaps during the implementation phase and it is questionable whether clients will fully return to the applicants after they have meanwhile established other supply chains (see also Section 5). Nevertheless, assuming a best case, it is expected that the applicants' production is fully relocated. If this would not be the case additional impacts due to lost business would have been counted in the assessment and the qualification costs would have to be reduced by a certain share. This would nevertheless result in higher overall impacts than the costs considered for relocation.

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32 Pictures of spindles can be found on the Oerlikon Balzer homepage http://www.oerlikon.com/balzers/epd/#about-epd.html

7.3.3 Loss of value added due to down-time

As already mentioned in Section 7.2.3, another factor that adds to the economic impacts in case of non-authorisation is the production downtime caused by the implementation of alternative technologies. In principle, all the arguments presented for NUS 1 also apply for NUS 2. The applicants expect that on average the complete implementation process of the new technology until full capacity and qualification of all components is reached would take in a best case approximately **Blank 1**. This time refers to the whole implementation and its different steps described in Section 7.3.

Meanwhile the new plating technology is implemented, pre-production lines like injection moulding lines for manufacture of plastic parts relying on the plating process will have to be shut down resulting in opportunity cost for the company. The total duration while the production would have to be stopped for deconstruction of the existing electroplating systems and installation PVD systems, is estimated by the applicants to take at least **Blank 1**. It is again the minimal amount of time, which is required to start the production without a full qualification of all components. This best-case approach considers that the production runs up gradually after the trial phase and components can be partly manufactured and sold to the OEMs without a complete qualification of the whole portfolio. For bigger sites even a longer period of time might be required. It is clear that the time frame required for implementation depends on availability of PVD systems on the market. As explained in above, it is questionable whether a sufficient number of PVD systems can be delivered in a time frame of a few months and whether all articles can be coated with one type of machines. Moreover, the coating of large articles using PVD is questionable, since chamber sizes are a limiting factor, and a selective plating of 2K/3K articles is impossible. The existing plants are planned to be running at full capacity and continuously, not being able to replace the electroplating system without a production stop. Furthermore, as previously explained, stock building is not possible and also maintenance intervals cannot be used for reconstruction, as a completely new technology needs to be implemented. The calculation of the opportunity cost during this period (**Blank 1** were assumed) was done using a metric suggested by members of SEAC in previous AfAs: *the added value foregone*. In order to calculate the added value foregone, the costs of inputs (except capital and labour) are subtracted from the turnover (net sales).

$$added\ value\ foregone = turnover\ (net\ sales) - costs\ of\ inputs\ (except\ capital\ \&\ labour)$$

For the calculation of the added value foregone it is necessary to consider the expected development of the company’s turnover in the upcoming years. Even though the market on chromium plated plastic parts is expected to grow (see Section 3), for the assessment of economic impacts it will be assumed that the turnover would be constant in real terms during the assessment period. This is to avoid overestimation of economic impacts.

Added value foregone

In 2014, the turnover of the 22 sites of the applicants related to the production of chrome plated plastic parts reached EUR Blank 1 while the correlated production costs (excluding labour and capital costs) amounted up to EUR Blank 1. Therefore, the annual amount of added value reaches EUR Blank 1. Considering that in real terms this amount would keep at least constant and that the production at all 22 sites would have to be shut down for a period of Blank 1, the impact of the downtime due to the implementation of the alternative is calculated below in Table 12 and Figure 23.

Table 12: Added value foregone with downtime in 2014 price levels.

Blank 1

Blank 1

Figure 23: Calculation of value added foregone due to downtime.

7.3.4 Loss of profit due to higher manufacturing costs and increased scrap rate

Table 13 summarises further aspects, which might increase the overall costs, when NUS 2 is implemented as standard procedure for the functional chrome plating of plastic components. First of all, process-related drawbacks increasing overall costs have to be mentioned in this context. A non-uniform and mostly smaller surface thickness compared to Cr(VI) based surfaces has to be considered in conjunction with the fact that in total several layers depending on the applied PVD method are deposited on the components. In order to avoid fissuring in the final application due to these little surface thicknesses the in-mold assemblies have to be modified in a costly way or even substituted. Furthermore, it has to be highlighted again that only a fractional amount of components can be processed by PVD techniques due to limited sizes of the PVD chambers and that a selective plating of 2K/3K components is not possible. In order to process the whole portfolio, chambers with dimensions of approximately 1.2 x 1.5 m would be needed. According to applicants, these machines cannot be delivered shortly both in required sizes and units. Higher energy costs represent another important aspect, which has to be taken into account. This claim can be underpinned by the fact that PVD is a high-vacuum process and, depending on the component to be coated, different temperatures are required. A cost increase for employees should not be neglected as well. On the one hand, workers have to be reskilled in order to be able to optimise parameters or handle process-related problems. On the other side, expensive and rare experts of this niche technology have to be hired. Finally, the afore-mentioned variations in quality due to a high sensitivity towards surface defects lead to a higher scrap rate (20-25 %) and thus to higher disposal costs.

Table 13: Aspects influencing process costs for the implementation of NUS 2 compared to Cr(VI) and estimated cost trends during the review period

Aspect	**PVD compared to Cr(VI)**	**Cost trend after implementation (during review period)**
Costs for chemicals	Much higher	→
Personnel costs	Slightly higher	↘
Energy costs	Slightly higher	↗
Other costs (scrap rate)	Much higher	↘
Depreciation	Higher	→
Total production costs	Much Higher	↘

An increase of production costs of **Blank 1** due to the change to PVD processes is estimated by the clients for the first 3 years. As a consequence of gained experience concerning procedural aspects, such as correct adjustment of process parameters leading gradually to less scrap rates and increasing expertise of workers, the additional costs are reduced to **Blank 1** and **Blank 1** for the years 4-6 and 7-12, respectively. This procedure is considered, since an overestimation of additional production costs is supposed to be avoided. Based on the estimations provided above and the economic figures presented in Section 7.2.4, the losses due to an increase of production costs has been calculated as shown in Figure 24.

Blank 1

Figure 24: Calculation of losses due to increase in production costs during the review period.

7.3.5 Impacts for the supply chain

The impacts which have to be expected for the supply chain are similar for all NUS. The reader is therefore referred to Section 7.2.5.

7.3.6 Social impacts

The expected social impacts are similar for all NUS. The reader is therefore referred to Section 7.2.6.

7.3.7 Summary of NUS 2

Figure 25 illustrates the required investments needed to implement NUS 2 and shows a comparison to health impacts.

[redacted]

Blank 1

Figure 25: Costs needed to invest for the implementation of NUS 2 compared to health impacts.

7.4. NUS 3: Relocation to non-EEA territory

This section summarises the expected socio-economic impacts for the NUS assuming relocation to non-EEA territory. As mentioned above, neither implementation of Cr(III) nor implementation of PVD is technically possible according to today's R&D status. Non-EEA competitors on the other hand can continue to use chromium trioxide based PoPAA and supply European OEMs with the required components. Consequently, the applicants' only real option according to today's information basis would be to relocate their production sites to non-EEA territory. It is clear from the applicants answers provided in questionnaires that not all investors/company owners will agree to do the required investments (in some cases it will simply be not economically possible due to financial resources) and therefore some companies will simply shut down and stop their business. Nevertheless, as a best case it has been assumed that all of the applicants' production lines will be relocated. Figure 26 illustrates the economic impacts that are considered in this NUS.

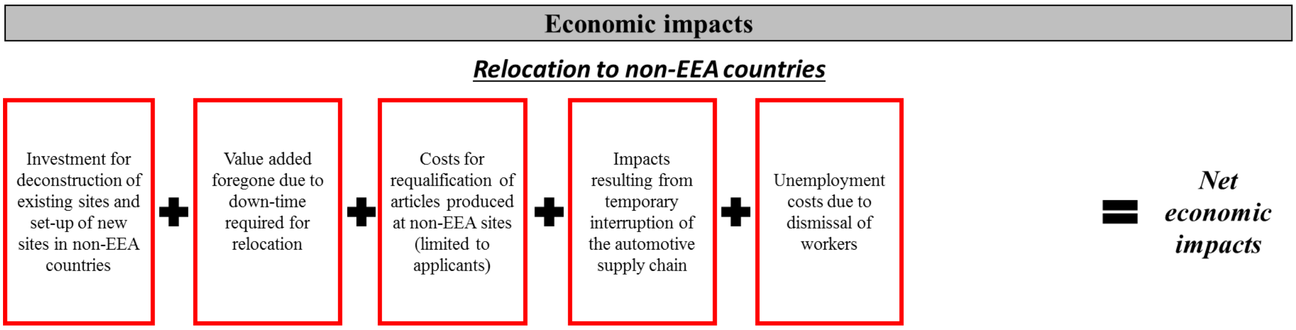

Figure 26: Net economic impacts considered in the NUS 3.

The applicants have been asked to provide information on steps required to relocate their sites to non-EEA territory. Furthermore indications regarding required time frames for implementation of the respective steps have been collected. Based on the applicants' information, the following overview summarising the minimum efforts necessary for relocation.

Based on the information provided by the applicants, at least the following steps have to be taken into account. In case of non-authorisation the applicants would directly start with the project planning. This step takes at least Blank and is more expensive compared to the one of Blank 1 and Blank 1, since, besides general aspects such as constructional and procedural issues; a lot of additional effort and strategic planning is necessary. Aspects such as safe production conditions, a continuous supply of raw materials, skilled workers and legal effects have to be considered as well as local logistics and the proximity to clients and suppliers due to transportation costs. As a parallel step to the project planning the site in the home country has to be closed, dismantled and disposed together with involved chemicals (including the cancelation of working contracts, indemnities for the workers, organisation of waste management companies, putting land in original condition). Once a country of production is fixed the search for land and the application for required permissions can be advanced. It is estimated by the applicants that these two steps take at least Blank 1 and Blank 1, respectively. However, the costs for these two aspects could not be estimated by the applicants due to a lack of experience as well as many uncertainties. Some countries might even subsidise a relocation for example with cheap land, which is hard to plan on. The construction of a new production building on the purchased land in the selected country is the next step followed by the construction of the production plant including wastewater technology, which takes at least Blank 1. In this context it is advantageous that a transfer of the old technology is possible and that the already gained expertise can be applied directly. Simultaneously, the acquisition of qualified workers is necessary in the case former ones are not willing to join. Neither the costs nor the time needed for this step could be estimated by the applicants; since the amount of required workers and the availability on site are hard to predict. Finally, the technology of the production plant has to be tested followed by a qualification of the produced components in-house and by the clients, whereat longer distances and transport difficulties have to be considered. A serial production will start at the earliest Blank 1 after the beginning of the project planning in consideration of parallel steps. Figure 27 summarises the mentioned procedures and gives approximate periods of time for each step. As a justification for a realistic estimation of required time to implement NUS 3 ANNEX C, which shows a schedule for the construction of an applicant's site in China, serves as an example.

Blank 1

Figure 27: Minimal amount of necessary steps and time needed for the complete implementation of NUS 3. Brighter colour shades indicate that single steps could take significantly longer, respectively.

7.4.1 Relocation costs

Table 14 illustrates the steps needed to relocate the production to non-EEA territory and gives ranges of costs and time, respectively. In total, EUR **Blank** (EUR **Blank 1** + EUR **Blank 1**) per site are needed in case the average costs for each step are considered, whereat the positions 'Shut-down of Plant' and 'Construction of Production Plant including Wastewater Systems' contribute most to the overall costs. Depending on the size of the respective sites, these values can vary significantly. Hence, the total sum needed to be invested for this NUS is EUR **Blank 1** for all applicants.

Table 14: Required steps and time and cost ranges for the implementation of NUS 3. Depending on the size of the respective applicant the respective data may vary significantly, which is considered for the determination of the average costs.

[redacted]

Blank 1

7.4.2 Costs for re-qualification

As stated in Section 7.2.2 it is assumed that the qualification costs are identic for all 3 NUS, since the necessary steps for the qualification do not significantly depend on the process of production. For the implementation of NUS 3 the same qualification costs of EUR **Blank 1** per site compared to NUS 1 and 2 are expected. This can be explained by the same number of required tests by the clients, no matter where or how the component was processed/produced.

Whether in reality the applicants will be able to provide the identical spectrum of articles after a relocation is unclear as the automotive suppliers and OEMs depending chrome plated plastic parts manufactured by the applicants will seek to close supply gaps during the implementation phase and it is questionable whether clients will fully return to the applicants after they have meanwhile established other supply chains (see also Section 7.2.5). Nevertheless, assuming a best case, it is expected that the applicants' production is fully relocated. If this would not be the case additional impacts due to lost business would have been counted in the assessment and the qualification costs would have to be reduced by a certain share. This would nevertheless result in higher overall impacts than the costs considered for relocation.

7.4.3 Loss of value added due to down-time

Another factor that adds to the economic impacts in case of non-authorisation is the production downtime required for relocation. In principle, all the arguments presented for NUS 1 and NUS 2 also apply for NUS 3. The applicants expect that on average the complete relocation process of the new technology would take in a best case approximately **Blank 1**. This time refers to the whole relocation and its different steps described in Section 7.4.

The calculation of the opportunity cost during this period was done using a metric suggested by members of SEAC in previous AfAs: *the added value foregone*. In order to calculate the added value foregone, the costs of inputs (except capital and labour) are subtracted from the turnover (net sales).

$$added\ value\ foregone = turnover\ (net\ sales) - costs\ of\ inputs\ (except\ capital\ \&\ labour)$$

For the calculation of the added value foregone it is necessary to consider the expected development of the company’s turnover in the upcoming years. Even though the market on chromium plated plastic parts is expected to grow (see Section 3), for the assessment of economic impacts it will be assumed that the turnover would be constant in real terms during the assessment period. This is to avoid overestimation of economic impacts.

Added value foregone

In 2014, the turnover of the 22 sites of the applicants related to the production of chrome plated plastic parts reached EUR **Blank 1** while the correlated production costs (excluding labour and capital costs) amounted up to EUR **Blank 1**. Therefore, the annual amount of added value reaches EUR **Blank 1**. Considering that in real terms this amount would keep at least constant and that the production at all 22 sites would have to be shut down for a period of **Blank 1**, which is a best- case estimate for the earliest possible production after relocation without full qualification of all components, the impact of the downtime due to the implementation of the alternative is calculated below in Table 15 and Figure 28.

Table 15: Added value foregone with downtime in 2014 price levels.

[redacted]

Blank 1

[redacted]

Blank 1

Figure 28: Calculation of value added forgone due to temporary stop of production.

7.4.4 Impacts on the supply chain

The impacts which have to be expected for the supply chain are similar for all NUS. The reader is therefore referred to Section 7.2.5

7.4.5 Savings due to reduced production costs and other general aspects

Table 16 shows further aspects, which influence the overall costs concerning the implementation of NUS 3. Depending on the country selected for relocation a significant reduction of the production costs, such as labour costs (at least **Blank 1**) and working costs (at least **Blank 1**), can be assumed. On the other hand, higher expenses have to be expected for transport and logistic costs, respectively. The cost trend for the following aspects is hard to summarise and estimate, nevertheless they should be mentioned in this context for the sake of completeness. First of all, a significant number of jobs (see Section 7.4.6) and production sites will get lost in the home country, in case the relocation of the production sites to non-EEA territory should be realised. A loss of image and a degradation of components is hard to predict, but might be a possible scenario depending on the selected country for relocation and production circumstances and should be kept in mind. However, it is assumed that certain advantages in competition due to a proximity to the key market might occur, which again varies depending on the country for relocation.

Table 16: Aspects influencing process costs for the implementation of NUS 3 compared to Cr(VI) and estimated cost trends during the review period

Aspect	Relocation compared to Cr(VI)	Cost trend after implementation (during review period)
Costs for chemicals	Slightly Lower	→
Personnel costs	Lower	↗
Energy costs	Lower	↗
Other costs (scrap rate)	Slightly Higher	↘
Depreciation	Higher	→
Transport costs	Much Higher	→
Logistic costs	Much Higher	→
Total production costs	Unclear	Unclear

In case of relocation, it was not possible to estimate the change in production costs as these highly depend on the non-EEA country chosen by applicants. At the moment, it is unclear to the applicants, which countries might be an option and therefore no change of production costs is assumed.

7.4.6 Social impacts

The expected social impacts are similar for all NUS. The reader is therefore referred to Section 7.2.6.

7.4.7 Wider economic impacts

In addition to the socio-economic impacts described in the previous sections, a non-authorisation is expected to incur wider economic impacts. These impacts are described briefly in the following.

Impacts on the governments (loss in taxes)

If the applicants would not be granted authorisation for the continued use of chromium trioxide in PoPAA, the amount of taxes and fees paid in Europe will be reduced by the amount, which is linked to all products produced by this industry. This represents a substantial loss of income for the EEA.

Impacts on economic development

As a consequence of the non-use scenario, the European automotive supply chain could piecewise move to non-EEA countries preventing revenue streams from the sector to continue and leading to considerable welfare losses for the EEA. Already today, there is a tendency to deliver complete assemblies (e.g. a radiator grille with a chrome trim) to the car manufacturers. It is very likely that in case of a non-granted authorisation these assemblies including the chrome plated plastic parts (here the chrome trim) are ordered at non-EEA suppliers. In consequence, also European automotive suppliers not using chromium trioxide (here the radiator grille) are widely affected by this authorisation and might lose business.

Impacts on trade and product quality

Especially high price products will be affected by a non-granted authorisation contributing significantly to the positive trade balance of Europe. In addition, Europe would become dependent on imports of products compulsively needed for their production lines with danger of supply disruptions, especially in industries like the automotive sector, where just-in-sequence deliveries are applied. Besides that, quality concerns can be expected and European know-how and technology would also move to non-EEA countries.

7.4.8 Summary of NUS 3

Figure 29 illustrates the required investments needed to implement NUS 3 and gives a comparison to health impacts.

Blank 1

Figure 29: Costs needed to invest for the implementation of NUS 3 compared to health impacts.

8. COMBINED ASSESSMENT OF IMPACTS

To summarise the previous assessment and to estimate the overall costs and benefits of a decision to grant or deny this application for authorisation (AfA), a combined assessment of impacts is set out here. A subsequent uncertainty analysis aims to assess the effects of uncertainties on the overall result of the SEA.

8.1. Comparison of impacts

Table 17 summarises the effects of a non-authorisation.

Table 17: Comparison of impacts for the applied for use and the non-use scenario

Type of impact	Applied for use scenario	Non-use scenario 1	Non-use scenario 2	Non-use scenario 3
Human health	Continued exposure of workers in Europe	No exposure of workers in Europe	No exposure of workers in Europe	No potential exposure of workers in Europe†
Environmental impacts	Negligible environmental impacts related to chromium trioxide	No environmental impacts related to chromium trioxide in the EEA Higher energy consumption resulting in increased CO2 emissions	No environmental impacts related to chromium trioxide in the EEA Higher energy consumption resulting in increased CO2 emissions	No environmental impacts related to chromium trioxide in the EEA‡ Higher CO2 emissions due to long-range transport of parts
Economic impacts	No investment costs for applicants No re-qualification costs No increase of production costs No losses due to down-time Production of all articles possible No compensation for dismissal of workers Contracts can be fulfilled Continued (growing) business guaranteed	Considerable investment costs for applicants Re-qualification costs Moderate increase of production costs Considerable losses due to down-time Production of all articles possible Compensations for dismissal of workers Contracts cannot be fulfilled due to temporary shut-down resulting in significant penalties	Massive investment costs for applicants Re-qualification costs High increase of production costs Massive losses due to down-time Partial loss of products as not all particles can be produced with PVD (2K/3K) Compensations for dismissal of workers Contracts cannot be fulfilled due to temporary shut-down	High relocation costs for applicants Re-qualification costs Unclear effect on production costs High losses due to down-time Production of all articles possible Compensations for dismissal of workers Contracts cannot be fulfilled due to temporary shut-down resulting in significant penalties Loss of business as

Type of impact	Applied for use scenario	Non-use scenario 1	Non-use scenario 2	Non-use scenario 3
		Loss of business as clients will search for alternative suppliers during temporary shut-down	and limited applicability resulting in significant penalties Loss of business as clients will search for alternative suppliers during temporary shut-down	clients will search for alternative suppliers during temporary shut-down
Social impacts	Maintenance of at least 5,795 jobs directly related to the use of chromium trioxide	Temporary loss of 80 % of jobs resulting in social impacts due to temporary unemployment	Temporary loss of 80 % of jobs resulting in social impacts due to temporary unemployment	Loss of 80 % of jobs resulting in social impacts due to temporary unemployment
Wider Economic impacts	Maintenance of taxes paid No negative impacts on the European supply chain and competitiveness No impacts on trade and quality	Less taxes paid due to higher production costs and partial loss of business due to temporary shut-down High impacts on the European supply chain due to interruption of supply chain Partial shift of the European automotive supply chain to non-EEA countries and loss of competitiveness	Less taxes paid due to higher production costs and partial loss of business due to temporary shut-down High impacts on the European supply chain due to interruption of supply chain Partial shift of the European automotive supply chain to non-EEA countries and loss of competitiveness	Loss of taxes paid in Europe High impacts on the European supply chain due to interruption of supply Shift of the European automotive supply chain to non-EEA countries and loss of competitiveness Cease of exports from the EEA Possible quality issues for OEMs Potential loss of R&D activities and innovation
† Expect at least the same number of workers would be exposed in non-EEA countries due to relocation. Additionally, non-EEA industries might have lower RMM than EEA industries. ‡ Expect environmental impact to be shifted to non-EEA countries. Increased impact associated with increased distribution of plated parts from non-EEA. Lower environmental standards in non-EEA countries.				

Table 18 below summarises the impacts for the applied for use and the non-use scenario in terms of monetised costs and benefits.

Table 18: Quantitative comparison of impacts for the applied for use and the non-use scenario

Type of impact	Discounting over 12 years [EUR million]
Benefits in economic terms of avoiding potential health impacts associated with the continued use of chromium trioxide	5.1
Benefits of avoiding health impacts through potential exposure ‘man via environment’	4.6
Socio-economic impacts	**Blank 1**
Net benefits of a granted authorisation	**Blank 1**

8.2. Uncertainty analysis

The ECHA Guidance on SEA (1) proposes an approach for conducting the uncertainty analysis. This approach provides three levels of assessment that should be applied if it corresponds.

- qualitative assessment of uncertainties;
- deterministic assessment of uncertainties;
- probabilistic assessment of uncertainties.

The ECHA Guidance further states: level of detail and dedicated resources to the assessment of uncertainties should be in fair proportion to the scope of the SEA. Further assessment of uncertainties is only needed, if assessments of uncertainties are of crucial importance for the overall outcome of the SEA.

As already explained in Section 6.1, the basic principle for the assessment of impacts in this SEA, was the estimation of health impacts based on worst-case assumptions compared to purposefully conservative (best case) calculations/estimations of social and economic impacts. Socioeconomic impacts that could not be qualified based on robust and reliable information were not counted and qualitative statements have been provided instead.

Calculation of health impacts is based on upper bound estimates of people potentially exposed (maximum number of potentially exposed workers) and the upper bound of exposure times and values, as elaborated in the CSR (worst-case estimates). By contrast, the calculation of social and economic impacts is based on the lower bound values provided by the applicants and very conservative assumptions regarding impacts on the supply chain.

As a consequence, human health impacts are likely to be overestimated and socio-economic impacts are very likely to be underestimated. As shown in Section 8.1 socioeconomic impacts in the ‘cheapest’ NUS still outweigh potential health impacts by a factor of 140 : 1 (although several additional impacts of a non-granted authorisation have not been considered in monetary terms). Hence, only a qualitative assessment of uncertainties has been conducted to summarise and describe potential sources of uncertainty related to the impact categories.

8.2.1 Qualitative assessment of uncertainties

Table 19 illustrates the systematic identification of uncertainties related to human health impacts and Table 20 to socio-economic impacts. Further arguments why health impacts are considered to be overestimated can be found in Section 6.2.3.

Table 19: Uncertainties on human health impacts.

Identification of uncertainty (assumption)	**Classification**	**Evaluation**	**Criteria and scaling (contribution to total uncertainty)**
Shape of exposure-response function (linear versus non-linear)[33]	Model uncertainty	If non-linear, particularly at low exposure levels: **overestimation** Especially exposure for MvE is several orders of magnitude below the range where linearity of the exposure-response function is guaranteed and in a range where it is unclear whether any effects can be expected.	High Health impacts calculated for MvE represent approximately 43.6 % of the total health impacts.
Number of persons considered for health impact assessment in the local scale in combination with exposure levels according to the CSR	Parameter uncertainty	If too high: **overestimation** In the CSR PEC_{local} is based on the 90^{th} percentile of emission data and 10,000 exposed persons per site have been assumed. This represents a hypothetical situation where for each site 10,000 persons are exposed with concentration occurring at the emission release point not considering dilution factors to be considered for distance between site and residence of exposed persons. Several sites are located in industrial areas with far less exposed persons.	High Health impacts calculated for MvE represent approximately 43.6 % of the total health impacts.

33 The study conducted by ETeSS on behalf of ECHA clearly states that: '[…] the lower the exposure (certainly below 1µg/m^3), the more likely it is that the linear [dose-response] relationship overestimates the cancer risk.' The study further states that 'the risk estimates for […] exposures lower than 1 µg Cr(VI)/m^3 might well greatly overestimate the real cancer risks. It is also considered that at progressively lower Cr(VI) air concentrations (from about 0.1 µg/m^3 downwards), cancer risks may be negligible'.

Number of exposed workers in combination with worst-case approach for exposure estimation	Parameter uncertainty	If too high: **overestimation** Applicants provided worst-case estimations for exposed persons per WCS and included persons not continuously present at relevant workplaces. Especially big production sites with high number of exposed persons have highest RMM standards and exposure levels below the figures given in the CSR.	Medium Especially health impacts calculated for WCS 2 and 3 representing 96.4 % of overall worker health impacts are overestimated.
PEC_{local} includes exposure concentration of $PEC_{regional}$	Parameter uncertainty	Double counting of health impacts for people already considered in PEC_{local} values: overestimation	Low

Table 20: Uncertainties on socio-economic impacts.

Identification of uncertainty (assumption)	**Classification**	**Evaluation**	**Criteria and scaling (contribution to total uncertainty)**
No growth of business assumed for the duration of the review period.	Parameter uncertainty	If business continuously grows as in the past: **underestimation**	Medium
Only time required to set up production lines has been considered for the value added foregone due to downtime.	Parameter uncertainty	In reality, only limited production will be possible during re-qualification. Losses due to reduced production during the qualification period have not been considered: **underestimation**	High
Full recovery of business after implementation of alternatives has been assumed.	Parameter uncertainty	In reality applicants will partly lose their business as not all customers will return after the stop of production required to implement alternatives. **underestimation**	Medium
Changes in production costs after relocation have not been considered.	Parameter uncertainty	It is unclear whether savings due to lower labour costs outweigh logistic costs. **impact unclear**	Low
Only lowest estimated impact for the automotive supply chain has been considered.	Parameter uncertainty	As considerations in chapter 7.2.5 demonstrate, it is not unlikely that an interruption of the automotive supply chain will result in impacts far higher compared to the EUR 756 million considered for the final assessment. **underestimation**	High
Job losses	Parameter uncertainty	Only 80 % job losses have been assumed for down-time periods. In reality full shut-down of at least some sites can be expected. **underestimation**	Low
Negative impact on trade, innovation and	Parameter	In case parts of the automotive supply chain are relocate to non-EEA countries	Low

Identification of uncertainty (assumption)	Classification	Evaluation	Criteria and scaling (contribution to total uncertainty)
R&D activities has not been quantified	uncertainty	R&D and innovation will be lost in the EEA as well as exports to non-EEA countries. **underestimation**	
Increased dependency of a strategically important industry sector from on non-EEA suppliers	Parameter uncertainty	Increased dependency from non-EEA suppliers could increase the risk for quality problems and less reliable supply. Reaction times for OEMs are increased due to longer transport of parts. This can have a negative impact on the automotive manufacturers and suppliers. **underestimation**	Low

8.2.1 Conclusion of uncertainty analysis

Overall, the uncertainty analysis demonstrates that the results of the SEA are robust and a factor of at least 140 : 1 between socio-economic impacts and health benefits is a very conservative estimation. It can reasonably be excluded that the uncertainties listed above could influence the results of the assessment in such a way that benefits of a granted authorisation need to be considered in the same range as health impacts. Even in case some of the impacts calculated for the NUS would not be accepted by the SEAC, the overall conclusion that the authorisation should be granted would not be at risk as every single impact considered in the assessment alone already outweighs the overall health impacts.

9. CONCLUSIONS

The aim of this socio-economic analysis (SEA) is to describe the socio-economic impacts of a non-granted authorisation of continued use of chromium trioxide in PoPAA and compare them to the residual risks to human health in case of a granted authorisation. Given the aims of the SEA, the analysis purposefully sought to characterise certain impacts but also, where appropriate, to under-value social and economic impacts, and over-value health impacts. This approach supports confidence in the findings of the assessment. The outcomes of this SEA for an assessment period of 12 years are briefly summarised in the following.

Overall, the three most likely NUS were discussed in this SEA and evaluated for technical and economic feasibility. As outlined in the AoA, today potential new technologies (NUS 1 and NUS 2) do not yet comply with the strict demands and requirements regarding crucial quality standards released by the OEMs and a change of this fact until the sunset date is not expected.

Blank 1

Considering the current technical status of Cr(III) and PVD a relocation of the production to non-EEA countries (NUS 3) turned out to be the most likely NUS at the sunset date. Though time required to set-up non-EEA sites, huge investments and other uncertainties are included as well, at least technical requirements and know-how available for PoPAA are available for the applicants, which partially already gained experience in setup of non-EEA production sites.

In general, downtimes, which are included for all three NUS, will immediately result in job losses and significant challenges and risks for the whole automotive industry. A gap in the supply chain resulting from a stop of PoPAA will force the OEMs to establish cooperation with non-EEA suppliers being able to offer PoPAA and therefore being able to close the gap. Building capacity equal to the applicants' output (> **Blank 1** parts per year) in non-EEA countries will take time. During the first months after the sunset-date, the lack of availability of chrome-plated parts will result in a loss of production at the OEMs and consequently a loss of business for the complete automotive industry. Once OEMs have implemented new supply chains in non-EEA countries with costly and time-consuming qualification, a return to the applicants after a resumption of production independent of the selected NUS is unlikely. The resulting loss of market shares will cause a significant reduction of competitiveness for the applicants and may threaten the applicants' business.

In order to avoid significant impacts on the automotive industry due to interruption of the supply chain and to guarantee competitiveness of the applicants' production in Europe a long review period of at least 12 years is required. Only a long review period will enable applicants and the OEMs to further develop the most promising alternatives for etching and plating and to implement alternatives in a step-wise approach in parallel to PoPAA. Splitting of the required investment costs over a longer time allows prospective financial planning and allows the applicants to withstand competition from non-EEA countries. Moreover, it has to be emphasised that capacities of technology providers for all potential alternatives are limited, which again supports a gradual implementation of a new technology during a long review period.

Considering all factors elaborated in this SEA, a review period of at least 12 years is clearly justified. Socio-economic impacts calculated for all NUS easily outweigh potential health impacts correlated with continued PoPAA (at least by a factor of 140:1). This is fact not only for the overall impact of the NUS but also for single impacts discussed for the 3 NUS. The uncertainty analysis demonstrates that socio-economic impacts are very likely underestimated. The AoA shows that there are promising alternatives in the R&D stage and considering the intensive R&D efforts the applicants have demonstrated to be willing to substitute Cr(VI). Taking into account the worst-case exposure levels provided in the CSR and the resulting worst-case health impacts of EUR 36,409 expected per site until 2029, a long review period that allows step-wise implementation of upcoming alternatives should be granted, avoiding also risks for the whole automotive industry which is of strategic importance of the European Union.

REFERENCES

1. (ECHA), European Chemicals Agency. *Guidance on the preparation of socio-economic analysis as part of an application for authorisation. Version 1.* Helsinki : European Chemicals Agency (ECHA), 2011.

2. ECHA. Application for Authorisation: Establishing a reference dose response relationship for carcinogenicity of hexavalent chromium. [Online] 2013. http://echa.europa.eu/documents/10162/13579/rac_carcinogenicity_dose_response_crvi_en.pdf.

3. EurLex. REGULATION (EC) No 1907/2006. [Online] [Cited: 6 May 2014.] http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02006R1907-20140410&qid=1399360593981&from=EN.

4. ECHA. Oficial Journal of the European Union. [Online] [Cited: 6 May 2014.] http://echa.europa.eu/documents/10162/a8ed0ded-e6ff-4407-8204-e0f3772af287.

5. ACEA, European Automobile Manufacturers Association. *The Automobile Industry Pocket Guide.* 2015/2016.

6. Alberini, Anna and Ščasný, Milan. *Stated-preference study to examine the economic value of benefits of avoiding selected adverse human health outcomes due to exposure to chemicals in the European Union. FD7. Final Report Part III: Carcinogens.* Prague : Charles University in Prague (Environment Center), 2014.

7. (ETeSS), Expert Team providing scientific support for ECHA. *Final report for hexavalent chromium.* Helsinki : s.n., 2013.

8. IARC. Lung cancer including trachea and bronchus. Estimated incidence, mortality & prevalence for both sexes, 2012. [Online] [Zitat vom: 20. January 2016.] http://eco.iarc.fr/EUCAN/Cancer.aspx?Cancer=18.

9. (RKI), Robert Koch Institut. Krebs in Deutschland 2011/2012. [Online] 2015. [Cited: 19 January 2016.] http://www.krebsdaten.de/Krebs/DE/Content/Publikationen/Krebs_in_Deutschland/kid_2015/krebs_in_deutschland_2015.html?nn=2640382. 10th edition.

10. ECHA. ECHA Guidance: Guidance on Information Requirements and Chemical Safety Assessment. [Online] [Zitat vom: 27th. May 2014.] http://echa.europa.eu/web/guest/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment.

11. IARC. Cancer of the large bowel. Estimated incidence, mortality & prevalence for both sexes, 2012. [Online] [Zitat vom: 15. January 2016.] http://eco.iarc.fr/EUCAN/Cancer.aspx?Cancer=10.

12. ECHA/RAC/SEAC. Industrial use of recycled soft PVC containing DEHP in polymer processing by calendering, extrusion, compression and injection moulding to produce PVC articles. *ECHA homepage.* [Online] 22nd. October 2014. [Zitat vom: 9th. July 2015.] http://echa.europa.eu/documents/10162/8d9ee7ac-19cf-4b1a-ab1c-d8026b614d7a.

13. Institute of Occupational Medicine. *Health, socio-economic and environmental aspects of possible amendments to the EU Directive on the protection of workers from the risks related to exposure to carcinogens and mutagens at work - Hexavalent Chromium.* o.O : s.n., 2011.

14. Dahlhaus, Dr. Markus. Tagung des Fachverbandes Galvanisierte Kunststoffe (Chrom 2020). *Chrom III-Verfahren in der Praxis.* 2015.

15. EFSI. [Online] [Cited: 25 11 2014.] http://www.efsi-europe.eu/fileadmin/MEDIA/publications/Cost_of_unemployment_report/English_Study_on_the_cost_of_unemployment_January_2013.pdf.

16. ECHA. [Online] 02 22, 2016. http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/applications-for-authorisation-previous-consultations/-/substance-rev/11318/del/50/col/synonymDynamicField_302/type/asc/pre/2/view.

17. [Online] 02 2016, 22. http://www.oerlikon.com/balzers/epd/downloads/OB_INUBIA_ePD_Bro_EN_140508_LowRes.pdf.

18. [Online] 22. 02 2016. http://echa.europa.eu/documents/10162/18074545/a4a_comment_684_1_attachment_en.pdf.

LIST OF TABLES

LIST OF FIGURES

ANNEX A HEALTH IMPACT ASSESSMENT

Number of potentially exposed people

Table 21 provides the relevant number of potentially exposed workers at the applicants' sites, potentially indirectly exposed workers and the potentially exposed general population which needs to be considered for the exposure route man via the environment (MvE).

Table 21: Number of people potentially exposed

Industrial workers at the applicants sites	5,795
General population ($PEC_{regional}$)	10 x 20,000,000 people
Potentially indirectly exposed workers and direct neighbourhood (PEC_{local})	20 sites x 10,000 people

The AfA to continue the use of chromium trioxide in the applicants' process is restricted to one specific industrial use only. Therefore, professional workers are not listed in the table above.

The human health impact assessment in the following sections is based on the methodology suggested by ECHA and described in Section 6.2 of this SEA.

Calculation of health impacts for potentially exposed people

Following the methodology described in Section 6.2, the calculation of the monetised health impacts for the continued use of chromium trioxide is performed. The exposure values derived in the respective CSR are used, corrected by the exposure times and the maximum number of potentially exposed people to calculate the total ELR (see Table 22).

In case of activities which are not performed every day; exposure values have already been corrected for frequency in the CSR and consequently factor 1 is applied.

Table 22: Activities (WCSs) and resulting ELRs

WCS	Exposure estimate (see CSR) [µg Cr(VI)/m³]	Days of exposure per year	Factor to adjust to work days[1]	Time corrected exposure from CSR [µg/m³]	ELR	Factor to adjust to review period (12/40 years)	ELR corrected by RP	Max. number of directly exposed people for the respective activity in 24 hours (1 working day)	Max. ELR for exposed workers (adjusted to frequency and RP)
1	0	not relevant	not relevant	0	0	0.3	0	not relevant	0
2	4.2E-01	240	0.92	3.88E-01	1.6E-03	0.3	4.7E-04	108	5.0E-02
	4.2E-01	250	0.96	4.04E-01	1.6E-03	0.3	4.8E-04	437	2.1E-01
	4.2E-01	265	1.02	4.28E-01	1.7E-03	0.3	5.1E-04	120	6.2E-02
	4.2E-01	290	1.12	4.68E-01	1.9E-03	0.3	5.6E-04	225	1.3E-01
	4.2E-01	300	1.15	4.85E-01	1.9E-03	0.3	5.8E-04	24	1.4E-02
	4.2E-01	321	1.24	5.19E-01	2.1E-03	0.3	6.2E-04	123	7.7E-02
3	1.2E+00	240	0.92	1.10E+00	4.4E-03	0.3	1.3E-03	21	2.8E-02
	1.2E+00	250	0.96	1.14E+00	4.6E-03	0.3	1.4E-03	72	9.9E-02
	1.2E+00	265	1.02	1.21E+00	4.9E-03	0.3	1.5E-03	50	7.3E-02
	1.2E+00	290	1.12	1.33E+00	5.3E-03	0.3	1.6E-03	21	3.3E-02
	1.2E+00	300	1.15	1.37E+00	5.5E-03	0.3	1.6E-03	15	2.5E-02
	1.2E+00	321	1.24	1.47E+00	5.9E-03	0.3	1.8E-03	28	4.9E-02
4	2.6E-02	240	0.92	2.40E-02	9.6E-05	0.3	2.9E-05	7	2.0E-04
	2.6E-02	250	0.96	2.50E-02	1.0E-04	0.3	3.0E-05	16	4.8E-04
	2.6E-02	265	1.02	2.65E-02	1.1E-04	0.3	3.2E-05	42	1.3E-03
	2.6E-02	290	1.12	2.90E-02	1.2E-04	0.3	3.5E-05	6	2.1E-04
	2.6E-02	300	1.15	3.00E-02	1.2E-04	0.3	3.6E-05	4	1.4E-04
	2.6E-02	321	1.24	3.21E-02	1.3E-04	0.3	3.9E-05	31	1.2E-03
5	1.4E-01	240	0.92	1.29E-01	5.2E-04	0.3	1.6E-04	13	2.0E-03
	1.4E-01	250	0.96	1.35E-01	5.4E-04	0.3	1.6E-04	67	1.1E-02
	1.4E-01	265	1.02	1.43E-01	5.7E-04	0.3	1.7E-04	40	6.8E-03
	1.4E-01	290	1.12	1.56E-01	6.2E-04	0.3	1.9E-04	12	2.2E-03
	1.4E-01	300	1.15	1.62E-01	6.5E-04	0.3	1.9E-04	4	7.8E-04
	1.4E-01	321	1.24	1.73E-01	6.9E-04	0.3	2.1E-04	28	5.8E-03
6	1.0E-03	260	1.00	1.00E-03	4.0E-06	0.3	1.2E-06	27	3.2E-05
7	4.0E-03	260	1.00	4.03E-03	1.6E-05	0.3	4.8E-06	39	1.9E-04
8	6.0E-04	260	1.00	5.95E-04	2.4E-06	0.3	7.1E-07	112	8.0E-05
9	6.8E-04	260	1.00	6.75E-04	2.7E-06	0.3	8.1E-07	126	1.0E-04
10	3.6E-02	260	1.00	3.55E-02	1.4E-04	0.3	4.3E-05	37	1.6E-03

See Table 23 for description of the activities carried out in the respective WCS.

Table 23: Activities (WCSs) relevant for potential worker exposure

WCS	Activity
1	Delivery and storage of raw material
2	Loading and unloading of jigs
3	Functional chrome plating – automatic line
4	Sampling
5	Decanting into dosing tanks and re-filling of baths
6	Decanting of solids
7	Re-filling of baths - solids
8	Regular maintenance and cleaning of equipment
9	Rare maintenance and cleaning of equipment

Based on the value for the total ELR which is calculated according to the following equation and a review period of 12 years (Section 6.2.1),

$$ELR = \frac{12\ years}{40\ years} \times 4\text{E-03 per } \frac{\mu\text{g Cr(VI)}}{\text{m}^3} \times \text{concentration} \left[\frac{\mu\text{g Cr(VI)}}{\text{m}^3}\right]$$

the equation for the calculation of the monetised health impacts for workers at The applicants sites is as follows

$$monetary\ value\ for\ fatal\ and\ non-fatal\ cancers\ =\ ELR\ \times EUR\ 5{,}732{,}676$$

Table 24 summarises the monetised impacts derived from the equations above in accordance with the ECHA Guidance on SEAs, for workers potentially exposed to chromium trioxide at the applicants' sites when continuing the use of chromium trioxide in the applicants' process. The analysis is based on a review period of 12 years. Following the worst-case approach by applying upper bound number of potentially exposed people at the site.

Table 24: Monetised health impacts for potentially exposed workers at the applicants sites

Group of potentially exposed people	Monetised value [EUR]
Workers	**5,050,770**

Potentially exposed population 'man via environment' human health impact assessment

The applied methodology and main underlying assumptions are given in Section 6.2. The calculations are provided for MvE_{local} and $MvE_{regional}$ and follow generally the calculations presented for the health impact assessment of potentially exposed workers. It should be noted that the following calculations are based on worst-case assumptions and therefore have to be regarded as overestimated. This fact is given by the very high number of people potentially exposed, which was taken into account following ECHA Guidance Chapter R.16: Environmental Exposure Estimation (Version 2.1 – October 2012) (10). Additionally, there is uncertainty about the dose-response curve at very low exposure values. The linear dose-response curve recommended by RAC might be too conservative for this exposure level (see Section 6.2 for further information).

$\underline{MvE_{local}}$

The total number of potentially indirectly exposed people is assessed taking into account the foreseen population of 10,000 people around one industrial site.

$$Number\ of\ potentially\ exposed\ people\ (local) = number\ of\ sites\ \times\ 10{,}000$$
$$= 20 \times 10{,}000 = \mathbf{200{,}000}$$

With the exposure values for PEC_{local} provided by the CSR and the above calculated number of potentially exposed people the further calculation follows the methodology described in Section 6.2.2:

The excess risks are calculated according to the following equations:

ELR lung cancer (local):

$$ELR = \frac{review\ period\ [years]}{70\ years} \times 2.9\text{E-02 per } \frac{\mu\text{g Cr(VI)}}{\text{m}^3} \times \text{ MvE local inhalation}$$
$$\times \text{ number of people potentially exposed}$$

$$= \frac{12\ years}{70\ years} \times 2.9\text{E-02 per } \frac{\mu\text{g Cr(VI)}}{\text{m}^3} \times 7.42\text{E-04 } \frac{\mu\text{g Cr(VI)}}{\text{m}^3} \times 200{,}000$$

ELR intestinal cancer (local):

$$ELR = \frac{review\ period\ [years]}{70\ years} \times 8.0\text{E-04 per } \frac{\mu\text{g Cr(VI)}}{\text{kg bw/day}} \times \text{ MvE local oral}$$
$$\times \text{ number of people potentially exposed}$$

$$= \frac{12\ years}{70\ years} \times 8.0\text{E-04 per } \frac{\mu\text{g Cr(VI)}}{\text{kg bw/day}} \times 4.60\text{E-03 } \frac{\mu\text{g Cr(VI)}}{\text{kg bw/day}} \times 200{,}000$$

In a second step, the monetised value for additional lung cancer cases is again calculated by multiplication of the ELR with the WTP value adjusted to the year of the sunset date:

Monetary value lung cancer:

$$monetary\ value\ for\ fatal\ and\ non-fatal\ lung\ cancers$$
$$= ELR\ \times EUR\ 5{,}728{,}611$$

Monetary value intestinal cancer:

$$monetary\ value\ for\ fatal\ and\ non-fatal\ intestinal\ cancers = ELR \times EUR\ 2{,}489{,}760$$

Table 25 shows the monetary value for health impacts for MvE_{local}.

Table 25: Monetised potential health impacts for MvE_{local}

General population - local	Monetised value [EUR]
MvE local inhalation	4,226,340
MvE local oral	314,137
Total	**4,540,477**

$MvE_{regional}$ inhalation

The total number of potentially indirectly exposed people is assumed with a population of 200,000,000 people around the applicants industrial sites.

With the exposure values for $MvE_{regional}$ provided by the CSR and the above calculated number of potentially exposed people the further calculation follows the methodology described in Section 6.2.2.

The excess risk is calculated according to the following equation:

ELR lung cancer (regional):

$$ELR = \frac{review\ period\ [years]}{70\ years} \times 2.9\text{E-}02 \text{ per } \frac{\mu\text{g Cr(VI)}}{\text{m}^3} \times \text{ MvE regional inhalation} \times \text{number of people potentially exposed}$$

$$= \frac{12\ years}{70\ years} \times 2.9\text{E-}02 \text{ per } \frac{\mu\text{g Cr(VI)}}{\text{m}^3} \times 2.99\text{E-}16\ \frac{\mu\text{g Cr(VI)}}{\text{m}^3} \times 200{,}000{,}000$$

ELR intestinal cancer (regional):

$$ELR = \frac{review\ period\ [years]}{70\ years} \times 8.0\text{E-}04 \text{ per } \frac{\mu\text{g Cr(VI)}}{\text{kg bw/day}} \times \text{ MvE regional oral} \times \text{number of people potentially exposed}$$

$$= \frac{12\ years}{70\ years} \times 8.0\text{E-}04 \text{ per } \frac{\mu\text{g Cr(VI)}}{\text{kg bw/day}} \times 3.08\text{E-}7\ \frac{\mu\text{g Cr(VI)}}{\text{kg bw/day}} \times 200{,}000{,}000$$

In a second step, the monetised values for additional cancer cases are calculated by multiplication of the ELR with the WTP value adjusted to the year of the sunset date (see above).

In a second step, the monetised values for additional lung cancer cases are calculated by multiplication of the ELR with the WTP value adjusted to the year of the sunset date (see above). Table 26 shows the monetary value for health impacts for $MvE_{regional}$.

Table 26: Monetised potential health impacts for $MvE_{regional}$

General population - regional	Monetised value [EUR]
MvE regional inhalation	0.002
MvE regional oral	21,033
Total	**21,033**

Summary

Table 27 provides a summary of total health impacts for workers and the general population related to the use of chromium trioxide at the applicants' sites.

Table 27: Summary table – monetised potential health impacts

Type of potentially exposed population	[EUR]
Potentially exposed workers	5,050,770
Potentially indirectly exposed workers and direct neighbourhood (MvE_{local})	4,540,477
General population 200 km x 200 km ($MvE_{regional}$)	21,033
Total	**9,612,280**

ANNEX B EXAMPLES OF QUALIFICATION TESTS

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ANNEX C SCHEDULE OF SITE CONSTRUCTION

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