ANALYSIS OF ALTERNATIVES

and

SOCIO-ECONOMIC ANALYSIS

Legal name of applicant(s):

Agbrigg Chrome Platers
Allenchrome Electroplating Ltd
Alpha Electroplaters Ltd
Birmingham Plating
Broadway Brass
Castle Polishing & Chrome Plating Ltd
Crown Polishing & Plating Ltd
Derby Plating Services Ltd
Doug Taylor Metal Finishing Co.
Douglas Metal Finishing Ltd
Essex Finishers Ltd
Fox Plating
Genius of the Lamp Ltd
Global Metal Finishers Ltd
HD Sports
Hockley Enterprises (Essex) Ltd
J&A Finishing Services Ltd
John Stokes Ltd
MAJ Hi-Spec Ltd
Manchester Electroplating Ltd
Marque Restore Chrome Plating Ltd
Merridale Polishing & Plating Ltd
Midland Polishing & Plating
Prestige Electro Plating
Quality Chrome Ltd
Reeve Metal Finishing
S & T Electro-plate
Sant Plating Ltd
Satchrome
Silchrome Plating Ltd
Star Polishing & Plating Ltd
The Sterlingham Co Ltd
Vernon Moss

Vintage Headlamp Restoration Ltd

Submitted by:	The Surface Engineering Association on behalf of the members of the Surface Engineering Association Chromium Trioxide Authorisation Consortium
Date:	30th June 2022
Substance:	Chromium Trioxide EC: 215-607-8 CAS: 1333-82-0
Use title:	Use of chromium trioxide for the electroplating of various components with technical performance requirements, such as for the brewery industry, construction sector, general engineering, sports equipment, fire protection, architectural hardware, medical devices classic/vintage cars & motorcycles, sanitaryware & plumbing with the purpose of creating a coating to provide specific performance characteristics and to match existing components and those supplied from other sources
Use number:	3

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TABLES

LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
AoA	Analysis of Alternatives
BAuA	German Federal Institute for Occupational Safety & Health
CTAC	Chromium Trioxide Authorisation Consortium
ECHA	European Chemicals Agency
GDP	Gross Domestic Product
JLR	Jaguar Land Rover
PVD	Physical Vapour Deposition
SEA	Socio-Economic Analysis
SVHC	Substance of Very High Concern

DECLARATION

We, the Applicants, are aware of the fact that further evidence might be requested by HSE / DEFRA to support the information provided in this document.

Also, we request that the information blanked out in the "public version" of the Analysis of Alternatives and Socio-economic Analysis is not disclosed. We hereby declare that, to the best of our knowledge as of today 30th June 2022 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.

Signed on behalf of the Applicants by the Surface Engineering Association representing the members of the Surface Engineering Association Chromium Trioxide Authorisation Consortium

Signature.

Name. David Elliott
Position. Chief Executive
Date. 30th June 2022
Place. Birmingham, UK

1.SUMMARY

This Analysis of Alternatives and Socio-Economic Analysis relate to the application for authorisation for the continued use of chromium trioxide in electroplating processes for components with specific technical performance requirements. Typical components are for the brewery industry, construction sector, general engineering, sports equipment, fire protection, architectural hardware, medical devices, classic/vintage cars & motorcycles, sanitaryware & plumbing.

The document has been produced by a consortium of chromium electroplating companies with the assistance of the Surface Engineering Association and their sector consultants. Full details of the companies are provided in a separate spreadsheet.

The function of the chromium trioxide is to provide a metallic chromium electroplated coating, which is essentially inert, usually termed decorative chromium plating. This term is, however, very misleading as a typical coating will consist of multiple layers, typically copper, nickel and chromium as per BS EN ISO 1456[1]. The chromium electroplating coating provides specific characteristics that include corrosion resistance, chemical resistance, wear / abrasion resistance, adhesion, UV resistance, heat resistance and visual appearance. In addition, the coating is fully recyclable.
Decorative chromium electroplating has been commercially available since the 1920's and the process has continued to be improved and developed. Much research and development has been undertaken to find alternatives to chromium electroplating using chromium trioxide and there are currently three particular technologies that could be considered as potential alternatives for this particular use. Tri-valent chromium electroplating, Physical Vapour Deposition (PVD) and metallic powder coating.

However, when examining the specific performance requirements of the required coating, none of the potential alternatives were considered to be viable alternatives at the present time nor in foreseeable future. A review period of 12 years is therefore requested. Any further research and development of these 3 potential alternatives and any newly developed coatings will be regularly monitored to ensure that the reasons for rejecting these potential alternatives is still valid. This monitoring will be undertaken by members of the consortium, the Surface Engineering Association and other actors along the supply chain.

The application for authorisation by the Chromium Trioxide Authorisation Consortium (CTAC)[2] submitted to the European Chemicals Agency (ECHA), stated As of today, no complete chromium trioxide free process, providing all the required properties to the surfaces of all articles in the scope of this application, is industrially available. This consortium included two of the largest suppliers in Europe of electroplating and surface engineering wet chemistry, clearly confirming the statements in the paragraph above.

1.1 Continued Use Scenario

The applicants will continue to use chromium trioxide under the ALARP[3] principles and, in conjunction with the Surface Engineering Association, will continue to monitor any R&D activity and development of potential alternatives. The applicants will continue to support UK manufacturing and contribute to the UK Government's Growth Agenda

1.2 Most Likely Non-Use Scenario

The most likely scenario if the application for authorisation is not granted is widespread business closures, supply chain disruption and relocation of manufacturing facilities outside of the UK.

1.3 Societal Costs on Non-Use

The societal costs resulting from non-use is £1,052M over a 4-year period, £6.8M of that resulting from unemployment and lost wages.

1.4 Residual Risks

When considering the worst-case scenario, the excess lung cancer risk is 0.0949 (due to the number of workers involved and the use of very conservative exposure data) and by the continued use of biological monitoring, all routes of exposure can be assessed and the principles of ALARP – as low as reasonably practicable – will be continued at all sites.

1.5 Conclusion

The societal costs of not granting this authorisation far outweigh the residual risks from the continued use of chromium trioxide by these applicants.

2. AIMS AND SCOPE

This application for authorisation covers the use of chromium trioxide in order to produce an electroplated coating of metallic chromium on top of underlayers of electroplated copper and nickel combinations. This SEA / AoA is part of the application for authorisation dossier produced by the consortium members.

The aim of the AoA is to demonstrate that no suitable alternatives to the use of chromium trioxide is currently available for this specific use.

The aim of the SEA is to demonstrate that the benefits of the continued use of chromium trioxide, for this specific use, far outweigh any potential risks to human health and / or the environment.

The scope covers the companies carrying out the chromium trioxide using process and their customers and details the societal implications of a refusal to grant an authorisation for the continued use of chromium trioxide for this specific use.

The companies using chromium trioxide are all based in the UK, so provide direct employment, generate tax revenues and preserve specialist engineering skills.

3. ANALYSIS OF ALTERNATIVES

3.1. SVHC use applied for

Use of chromium trioxide for the electroplating of various components with technical performance requirements, such as for the brewery industry, construction sector, general engineering, sports equipment, fire protection, architectural hardware, medical devices, classic/vintage cars & motorcycles, sanitaryware & plumbing with the purpose of creating a coating to provide specific performance characteristics and to match existing components and those supplied from other sources

3.1.1. Description of the function(s) of the Annex XIV substance and performance requirements of associated products

Chromium trioxide is used to produce an electroplated metallic chromium coating. The base materials can vary and often include steel, castings, die-cast and alloy materials such as mazak / zamak (base material zinc and alloying elements of predominately aluminium but also magnesium and copper) and brass. For this specific use, it is part of an integrated process which consists of a number subsequential process steps as shown below:

A – Pre-treatment processes

These processes clean the surface of the component to ensure that the surface is clean and ready to accept the electroplating processes. These processes can also remove the electroplating from previously coated components. They also can include polishing processes in order to obtain a mirror-like finish.

B – Electroplating processes

These will be a combination of dull copper, bright copper, nickel, duplex nickel, chrome

C – Post-treatment processes

These processes will ensure that the surface does not contain any chromium trioxide residue from the electroplating stage.

Between each process stage there are rinsing processes to ensure the removal of any surface contaminants from previous processing steps.

It is very important to note that the final coated component does not contain any chromium trioxide, so the only potential exposure to chromium trioxide occurs within the company operating the chromium electroplating process – the applicants who have submitted this application for authorisation. So, we are primarily concerned with workplace exposures.

The chromium electroplated components for this specific use require the following performance requirements:

A - corrosion resistance,

B - chemical resistance,

C - wear / abrasion resistance,

D - adhesion,

E - UV resistance,

F - heat resistance and

G - visual appearance / aesthetic qualities

3.1.2. Market analysis of products manufactured with the Annex XIV substance

Typical components that require decorative chromium plating for this use are:

Ice-skate Blades, Medical equipment (e.g., Ventilators), Aircraft components, Gas-flow measuring instruments, Fire-protection equipment, Door furniture (handles, etc.).

These examples, and many more, with *Technical Performance* as their prime requirement, drive the Market demand and 'failure' of coatings can endanger the safety of the end-user.

3.1.3. Annual volume of the SVHC used

The annual volume of chromium, trioxide used in the electroplating for this specific use is 11 to 14 tonnes per annum in total.

3.2. Efforts made to identify alternatives

The application for authorisation by the Chromium Trioxide Authorisation Consortium (CTAC) submitted to the European Chemicals Agency (ECHA), stated "as of today, no complete chromium trioxide free process, providing all the required properties to the surfaces of all articles in the scope of this application, is industrially available". This consortium included two of the largest suppliers in Europe of electroplating and surface engineering wet chemistry, clearly confirming the absence of a drop-in replacement for chromium trioxide.

Despite this, some the companies that have made this application have made significant efforts to find alternatives. Each of the applicants has provided information on the efforts they have made, and full details are given in Appendix 1. Here are a few extracts:

Company 1
Over 50% of our chrome plated parts are plated to BS EN ISO 1456:2009 before being exported to the US. The finish needs match identical plated components supplied to our customer in the US in both colour and corrosion performance. A significant percentage of another customer's plated parts are shipped to Sweden, and these also need to match other parts that are sourced from the far east.

Company 2
We have been processing components for UK manufacturers of wire-work to BS EN ISO 1456:2009 for many years.
Trivalent Chrome processes do not give the required corrosion protection at the weld points, leading to discolouration at the joint.
Also, variations in colour of Trivalent Chrome processes would result in incompatibility of assembled components sourced from suppliers outside of the EU who continue to supply parts produced using Hexavalent Chrome. This could lead to ALL components being imported.

Company 3

We have tried PVD coatings like Nitron MC (tungsten/carbide deposition) but the market rejected this due to after-market service/sharpening from the retailers. Furthermore, the athletes reported the steel was "too hard." Lastly, this technology is cost-prohibitive for us to use at scale.

We've tried trivalent chrome, but this didn't offer the hardwearing and protection our products require in such a harsh environment.

As we develop new products, we are trying to move away from needing chromium trioxide but the market is still resistant to many of the changes. Whilst there is a small segment of the market that has accepted a stainless-steel runner, we've offered a product line to capture this market. Additionally, we have designed newer blades with less surface area (the Coronation Ace Lite and the Professional Lite) which require less chrome coverage.

3.2.1. Research and development

Chromium electroplating using trivalent chromium was first commercialised in the early 1970s by Albright & Wilson in the UK, despite patents being issued as far back as the late 1920s. There has been considerable research and development activities since that time, mainly by the key chemistry suppliers to the sector and this activity is on-going in order to try and obtain a true alternative to chromium electroplating using chromium trioxide.

The applicants rely on the chemistry suppliers and Universities to conduct research and developments as the costs are prohibitive to small and medium-sized businesses. The sector association, the Surface Engineering Association, keeps abreast of research and development activities on a global scale and has been involved in a number of UK Government and EU funded project to develop alternative coatings. Any information gathered by the SEA will be circulated to the consortium members.

3.2.2. Consultations with customers and suppliers of alternatives

Members of the consortium have been in regular discussions with their customers and the suppliers of surface engineering chemistry and examples of discussions can be seen in section 3.2

3.2.3. Data searches

On behalf of the consortium members, the Surface Engineering Association carries our regular data searches via academic journals and Research Gate. They also maintain regular contact with other key associations around the world such as National Association for Surface Finishing (USA), European Committee for Surface Treatments (CETS), Metal Finishers' Association of India (MFAI).

3.2.4. Identification of alternatives

Following extensive research over a number of years, there are 3 potential alternatives for this use of chromium trioxide for chromium electroplating. These 3 alternatives are all "advertised" as suitable alternatives but they are not suitable for this certain, specific application. The 3 potential alternatives are:

A) Using trivalent chromium chemistry
B) Using physical vapour deposition (PVD)
C) Using metallic powder coating

All of these alternatives were considered in a report published in 2020 by the Federal Institute for Occupational Safety & Health (BAuA)[4] in Germany, entitled "Survey on technical and economic feasibility of the available alternatives for chromium trioxide on the market in hard / functional and decorative chromium plating. They concluded:

As surfaces deposited from chromium trioxide electrolytes serve multiple purposes in the product, it is challenging to find a one-to-one replacement or single alternative technology which can fulfil all requirements in different areas of application at once. This can pose a relevant economic problem for small or medium sized electroplating subcontractors, who cannot afford to provide several different alternative processes, but would have to in order to serve their diverse clients' needs. In the scope of this survey – without claiming completeness – several applications were identified where currently none of the discussed alternatives are technically feasible.

3.2.5. Shortlist of alternatives

Table 1: Shortlisted alternatives.

Number	**Alternative name**	**CAS or EC Number (where applicable)**	**Description of alternative**
1	Trivalent chrome	N/A	Chromium electroplating using a trivalent chromium-based processing solution
2	PVD	N/A	Physical Vapour Deposition to produce a metallic chromium coating
3	Powder Coating	N/A	Powder Coating using metallic based powders

3.3. Assessment of shortlisted alternatives

3.3.1. Alternative 1: Trivalent chromium

3.3.1.1. General description of Alternative 1

In this potential alternative process, the chromium trioxide is replaced by a number of other substances to produce a different process technology. Decorative chromium electroplating with trivalent chromium chemistry enables the deposition of metallic chromium onto components. The component to be coated is immersed in the trivalent chromium electroplating solution, which contains dissolves trivalent chromium salts, additives such as ammonium salts which act as complexing agents and boric acid which acts as a buffering agent to control the ph of the solution.

The actual composition of the chromium trioxide plating solutions depends on the performance requirement of the coating produced. The most commonly used types of chemistry for this particular type of coating are either sulphate based or chloride based chromium trioxide solutions.

Trivalent chromium electroplating is based on the same principle of electrodeposition as chromium trioxide electroplating and can be undertaken using similar plant and equipment as chromium trioxide electroplating. However, there are major differences such as chemical composition of the electroplating solution and its control, the operating parameters and the need for additional ancillary equipment such as ion exchangers. This will involve significant capital investment for SMEs.

3.3.1.2. Availability of Alternative 1

Trivalent chromium electroplating solutions are in use worldwide for various specific products. However, they currently do not meet all of the performance requirements for this particular use and, even if they did, there would be a requirement for significant capital investment, which is just not feasible in the current economic climate.

3.3.1.3. Safety considerations related to using Alternative 1

The following is an extract from the application for authorisation submitted by the chromium trioxide authorisation consortium, including 2 of the main suppliers of process chemistry in the UK.

As the alternative is not technically feasible, only classification and labelling information of substances and products reported during the consultation were reviewed for comparison of the hazard profile. Based on the available information on the substances used within this alternative, chromium (III) chloride would be the worst case with a classification as Skin Irrit. 2, Eye Irrit. 2, Acute Tox.

In general, the trivalent electroplating processes are less toxic than chromium trioxide plating due to the oxidation state of the chromium. Cr(III) solutions do not pose serious air emission issues, but still pose the problems of disposal of stripping solutions (depending on the type of stripping solution) and exposure of staff to chrome dust during grinding. In addition, there is a certain risk of Cr(VI) being generated during the plating process (anodic oxidation of Cr(III) ions). This is why appropriate security *precaution and process management has to be adopted to prevent the formation of Cr(VI).*

The Cr(III) bath electrolyte solution typically also contains a high concentration of boric acid, which is an SVHC (Repr. 2; H361) included on the candidate list and currently on the 6th recommendation for inclusion in Annex XIV. Overall, the transition from Cr(VI) to Cr(III) technology constitutes a shift to less hazardous substances, despite one of the used alternative substances is itself classified for mutagenicity and carcinogenicity. Hence, any replacements will need to be carefully evaluated on a case by case basis.

It should be understood that replacing chromium trioxide involves the use of many more substances rather than just one substance. The following are typically required in trivalent chromium electroplating solutions:

Chromium Sulphate EC: 233-253-2 CAS: 10101-53-8
Chromium Chloride EC: 233-038-3 CAS: 10025-73-7
Chromium Trichloride Hexahydrate EC: 629-714-6 CAS: 10060-12-5
Boric Acid EC: 233-139-2 CAS: 10043-35-3
Ammonium Chloride EC: 235-186-4 CAS:1215-02-9

According to the ECHA chemicals database, Chromium Trichloride Hexahydrate is classified as toxic to aquatic life with long lasting effects, causes serious eye irritation, is harmful if swallowed, may cause respiratory irritation, causes skin irritation, may be corrosive to metals and may cause an allergic skin reaction. So any potential alternatives need to be fully evaluated and assessed before use.

3.3.1.4. Technical feasibility of Alternative 1

When attempting to move from a chromium trioxide based solution to a trivalent chromium based solution for chromium electroplating, it would from a technical point to be a potential drop-in replacement. This is because the majority of the existing process plant and equipment can be used for both processes. However, as previously stated, additional plant and equipment will be required along with significantly tighter process control parameters. Trivalent chromium electroplating solutions are very sensitive to impurities and process temperature, therefore ion exchange units are required to remove contaminants on a continual basis and cooling of the process solution is often required. Also, to ensure that components being processed are free from contaminants from previous processing stages, extra rising stages are required before the chromium trivalent electroplating process.

Trivalent chromium chemistry is much more sensitive to metallic impurities and to the ph of the bath than conventional chromium trioxide chemistry. Even small deviations in the process conditions can strongly influence the deposition success, the layer quality, performance and the final appearance.

It should also be remembered that most of the consortium members do not operate their plants on a continual basis, often for only 1 to 3 days per week, and therefore the process solutions needs to be able to cope with being left idle for extended periods and trivalent chromium solutions have shown to be not suitable for this types of process arrangement.

Examining some the specific technical requirements of the chromium electroplated coating for this particular use we see:

Corrosion resistance – Extensive studies have been undertaken and referenced in other applications for authorisation for the continued use of chromium trioxide. To summarise, the corrosion resistance of electroplated chromium using trivalent chromium chemistry is dependent on many differing parameters. These include the type of process chemistry being used, the electroplated under-layers and any potential post-treatments used to enhance the corrosion resistance. Based on the information supplied by the members of the consortium, the corrosion resistance of chromium electroplating using trivalent chromium process chemistry does not currently meet the requirements of the legacy market.

Chemical resistance – information provided by the members of the consortium and given in previous applications for authorisation show that the chemical resistance of electroplated chromium from trivalent chromium chemistry is lower than when using chromium trioxide. Based on the information supplied by the members of the consortium, the chemical resistance of chromium electroplating using trivalent chromium process chemistry does not currently meet the requirements of the legacy market.

Wear / abrasion resistance – Although these two terms are often seen as interchangeable, wear is the loss of material from the surface of a material and abrasion is one of the actions which can cause wear. The chromium plating produced from trivalent chemistry tends to have a lower hardness and therefore lower wear resistance, although improvements are continued to be made by modifying process parameters. Based on the information supplied by the members of the consortium, the wear / abrasion resistance of chromium electroplating using trivalent chromium process chemistry does not currently meet the requirements of the legacy market.

Adhesion – the adhesion performance of the chromium electroplating from trivalent chromium chemistry is deemed to be acceptable for this particular use.

UV Resistance – the UV resistance of the chromium electroplating from trivalent chromium chemistry is deemed to be acceptable for this particular use.

Heat Resistance – the heat resistance of the chromium electroplating from trivalent chromium chemistry is deemed to be acceptable for this particular use.

Visual Appearance – the colour of the electroplated chromium coating produced from trivalent chromium process chemistry differs according to the make-up of the process solution and any impurities present. As coatings for the heritage market have to match those produced many years ago, the visual appearance of chromium electroplating from trivalent chromium chemistry does not meet the specific requirement of this use.

3.3.1.5 Economic feasibility of Alternative 1

Chromium electroplating from trivalent chromium solutions tend to be more expensive but recent advances have led to this gap closing when all factors, apart from the capital investment required, are taken into consideration:-

Initial solution make-up – this is an initial one-off cost to make-up the trivalent chromium process. Account also has to be taken of the potential disposal costs of the chromium trioxide containing process solution, if this potential alternative were to be adopted.

Regular solution maintenance – as the trivalent chromium process chemistry requires more substances and additives, costs are higher.

Ion exchange – ion exchange units will have to be purchased (capital investment & increased energy consumption) to ensure that any impurities in the trivalent chromium process are removed. This removal is a continuous process.

Effluent Treatment – changes will be required to the effluent treatment plant / processes in order to handle the new substances. Typical effluent treatment plants at electroplating facilities will work on an alkaline precipitation model. Changes will be required to ensure that the treatment of an ammonium containing process solutions doesn't occur above ph 9 as there is a potential for ammonia to produced and released into the atmosphere.

Process Analysis – a typical chromium trioxide plating solution will require no more than 2 hours of analysis time each week. A typical trivalent chromium plating solution will require around 2 hours of analysis each day.

Re-Engineering – the process line will have to be re-engineered to account for the extra ion exchange processes and the extra rinsing requirements to avoid impurities. There is often simply no extra space to re-engineer process lines and certainly not to run both systems in tandem during trial periods.

Anode Materials – the trivalent chromium process uses platinised titanium anodes rather than lead.

Energy Consumption – as the trivalent chromium process uses a lower current density, less energy is consumed. However, it is often found that the solution has to be cooled during operation, so this will lead to an increase in energy

Throwing Power – the throwing power is generally better with trivalent chromium solutions meaning that higher production levels can be achieved.

3.3.1.6 Suitability of Alternative 1 for the applicant and in general

Whilst considerable research and development has been completed and is still on-going, the use of trivalent chromium process solutions is not considered as a suitable alternative for this particular use.

3.3.2 Alternative 2 – PVD processes

3.3.2.1 General Description of Alternative 2

PVD – Physical Vapour Deposition, refers to a vacuum coating process in which a film of coating material is deposited atom by atom on the substrate material by the process of condensation from the vapour phase to the solid phase. The two most common PVD Coating processes are Sputtering and Thermal Evaporation. Sputtering involves the bombardment of the coating material known as the target with a high energy electrical charge causing it to "sputter" off atoms or molecules that are deposited on a substrate. Thermal Evaporation involves elevating a coating material to the boiling point in a high vacuum environment causing a vapor stream to rise in the vacuum chamber and then condense on the substrate.

The first patent for a PVD type coating was filed by Edison in 1884 and issued in 1894 and mentioned electro vacuous deposition. Since then, many technological advances have been made with the process and process equipment.

Titanium Nitride (TiN), Chromium Nitride (CrN), Titanium Aluminium Nitride (TiAlN), Titanium Boron Nitride (TiBN) are some examples of PVD coatings.

3.3.2.2 Availability of Alternative 2

PVD coatings are widely available and are used extensively in the semiconductor, microelectronics and cutting tool industries. The biggest drawback is the cost of the capital investment required to purchase the coating machinery in order to produce and maintain the vacuum and vaporisation of the coating material.

3.3.2.3 Safety considerations related to using Alternative 2

In terms of substance / chemical use, PVD type coatings show a reduction in risk as they currently do not use any substances that are classified as SVHC – substances of very high concern.

However, a significant re-training programme would be required in order for the current employees to firstly understand the PVD process, know how to use it safely and how to maintain it in a safe working manner. The current electroplating process does not use any vacuum or vapourising technologies.

3.3.2.4 Technical feasibility of Alternative 2

PVD coatings have the following technical limitations when being considered for this particular use:

Corrosion Resistance: PVD coatings can suffer from pinholes, which then leads to pitting in typical use. Research is still ongoing and combination PVD coatings are now offering enhanced corrosion resistance. Currently the PVD coatings do not meet the corrosion resistance requirements for this use.

Vacuum/Geometry: The requirement of a vacuum chamber limits the size and the type of parts that can be coated. It should also be remembered that PVD coatings are line of sight processes and are not suitable for complex geometries and large parts, such as car bumpers.

Operating parameters: The process conditions for PVD require sub-atmospheric pressures and temperatures between 150 and 600°C. Process temperature, especially towards the upper limit can restrict the substrate materials that can be coated.

Cleanliness: PVD coatings require an atomically clean surface because they are highly sensitive to contaminants (e.g. water, oils and paints) on the surface to be coated. In fact, inadequate or non- uniform ion bombardment leads to weak and porous coatings and is the most common cause of failure in PVD coating. Therefore, an extremely efficient cleaning and drying method is required for this process.

Hardness: PVD Coatings can produce very high hardness coatings but this can lead to internal stresses being developed during processing.

Wear Resistance: wear resistance is comparable if not superior to electroplated chromium but because the coating is extremely thin (hence the name thin film deposition), the long-term wear can be limited.

When considering the technical feasibility of alternative 2, it is not considered to meet the technical requirements for this use.

3.3.2.5 Economic feasibility of Alternative 2

Due to the technical shortcomings of the PVD coating processes, the following overview has been obtained through industry contacts and members of the consortium:

If a change from electroplated chromium using chromium trioxide to a PVD Coating was envisaged, the installation of a completely new production line would be required as PVD coatings cannot be produced on existing electroplating lines – it is a complete change of technology.

The throughput of a typical PVD coating process (including cleaning & loading) would be considerably lower than that for electroplating by a factor of almost 50%. The initial start-up costs for a PVD coating process would be prohibitive for all members of this consortium. A new PVD Process line capable of processing the typical components for this use would cost more than the total annual sales value of the companies applying for authorisation for this use.

Feedback showed that the typical operating costs were often 30-40% higher and new, technical knowledge will be required. Typical members of this consortium have built up many years of technical knowledge and heritage skills, and it would take them many years to fully understand this new type of process.

When considering the economic feasibility of alternative 2, it is not considered to be a valid alternative at present.

3.3.2.6 Suitability of Alternative 2 for the applicant and in general

Whilst considerable research and development has been completed and is still on-going, the use of PVD processes are not considered as suitable alternatives for this particular use.

3.3.3 Alternative 3 – Metallic powder coating process

3.3.3.1 General Description of Alternative 3

Powder coating is a type of coating that is applied as a free-flowing, dry powder. Unlike conventional liquid paint which is delivered via an evaporating solvent, powder coating is typically applied electrostatically and then cured under heat or with ultraviolet light.

Metallic powder coatings are made by mixing metal powder or flakes into the powder paint. Metallic powders come in two qualities, bonded and unbonded, and it is the bonded metallics that are suitable for one step application as they contain a bit of clear powder. The unbonded metallics need to be finalised by a transparent or translucent powder.

3.3.3.2 Availability of Alternative 3

Metallic powder coating has seen a considerable growth in recent years, primarily in architectural & consumer goods markets. In is becoming more popular with the automotive sector now with the development of aluminium pigments. Metallic powder coating is widely available although research continues to enhance the performance characteristics of the coating.

3.3.3.3 Safety considerations related to using Alternative 3

Chromium trioxide is a non-threshold carcinogen and is considered a Substance of Very High Concern (SVHC). Powder coating is considered to mainly use substance less hazardous than chromium trioxide and therefore, the transition from chromium trioxide to powder coatings would constitute a shift to less hazardous substances.

However, some powder coatings have contained triglycidyl isocyanurate, a cross-linking agent and this is also classed as an SVHC. Most modern-day powders do not contain this substance.

Nevertheless, it has to be considered that the application of powder coatings may generate an explosive atmosphere and special explosion prevention measures may become necessary. In case of transition, any replacement will need to be carefully evaluated on a case by case basis.

3.3.3.4 Technical feasibility of Alternative 3

Essentially, the electrostatics, among other things, have an effect on the way the metallic flakes in the powder orient. A small change in flake orientation can change the colour of the coating, especially when there is a large contrast between the base colour and the colour of the metallic flake. This present a significant obstacle as colour matching and aesthetic appearance are key coating requirements for this use.

Metallic powder coatings are denser than other powder materials. This makes it harder to fluidize and deliver the metal flake materials. Challenges such as uneven film thickness (varying deposition of effect pigments gives rise to color or effect change) arise during application.

The coating produced with metallic powder coating does not meet the hardness / wear resistance requirements for this use.

The corrosion resistance of some metallic powder coatings is impressive, so long as the coating remains completely intact and is not damaged by any wear or abrasion – this would be extremely difficult to eliminate for this use.

When considering the technical feasibility of alternative 3, it is not considered to be a valid alternative at present.

3.3.3.5 Economic feasibility of Alternative 3

Metallic powders are more expensive than solids, especially if it is a bonded metallic powder coating. The reason is the extra processes involved in creating a bonded metallic powder. Also, some metallics require a clear top-coat, and others require a base coat. Even if the metallic needs one of those requirements, it is an extra step in the manufacturing process and therefore cost added onto a job. Metallic powders can be more difficult to spray than solid colour powders.

Metallic powder coating would require a new production line and these are available with in-built pre- and post-treatment. However, all of the members of this consortium are small / medium companies and would find it extremely difficult if not impossible to raise the capital investment required for a new production line.

The majority of the consortium members only operate their process plant periodically and the curing / post-treatment of the metallic powder coating is not designed for such an operation. It may be that the development of UV curable metallic powder coatings could assist in this area.

When considering the economic feasibility of alternative 3, it is not considered to be a valid alternative at present.

3.3.3.6 Suitability of Alternative 3 for the applicant and in general

3.4 Conclusion on shortlisted alternatives

Whilst all the three potential alternative coatings can, and have, replaced chromium trioxide in decorative chromium plating for specific products with specific technical and performance requirements, none of them are currently considered to be viable alternatives for this particular use.

4 SOCIO-ECONOMIC ANALYSIS

4.1 - Continued use scenario

4.1.1 Summary of substitution activities

The applicant and several other members of this group of users, have researched the potential alternatives to chromium trioxide and have received sample components from suppliers of the potential alternative process equipment or material.

On assessment, none of the alternatives satisfy all the performance and aesthetic criteria required by the end users of the articles being coated. The most important performance criteria being corrosion resistance and chemical resistance with no alternative able to satisfy these criteria.

To the end user, the immediately obvious criteria are visual appearance and colour consistency where the component parts should have the same appearance i.e., "match" all other chromium plated parts in the installation – regardless of where or when they are sourced. None of the potential alternatives can satisfy these requirements.

4.1.2 Conclusion on suitability of available alternatives in general

As a result of the unacceptability of alternatives, to the end users, the conclusion is that the applicants have no available or potential alternative processes likely to be introduced for the foreseeable future.

Therefore, it is not possible to produce a substitution plan.

4.1.3 R&D plan

The applicant and other group members are either Small or Micro Enterprises, as defined in the EU recommendation 2003/361, and as such do not have access to funds to enable individual R&D activity and, in most cases, do not have the floorspace or manpower to accommodate the necessary process facilities.

The applicants must, therefore, rely on R&D carried out by the major process chemistry suppliers and Universities as the costs are prohibitive to micro, small and medium-sized businesses. The sector association, the Surface Engineering Association, keeps abreast of research and development activities on a global scale and has been involved in a number of UK Government and EU funded projects to develop alternative coatings. Any information gathered by the SEA will be circulated to the consortium members.

4.2 Risks associated with continued use

Given that all of the results from the Workers biological monitoring reports are within (or below) the range expected for the unexposed population i.e., <10µmol/mol creatinine and that there are no discharges of chromium trioxide to the environment, there is no excess lifetime risk to individuals (worker or general population) or to the environment. However, as chromium trioxide is classified as a non-threshold carcinogen and using the dose response relationship for exposure to chromium trioxide developed by the Risk

Assessment Committee of the European Chemicals Agency, there is an excess lung cancer risk of 2 X 10^{-3} by considering the worst-case scenario.

The worst-case assessment of worker health risks within this socio-economic analysis utilises the results of a study endorsed by ECHA identifying the reference dose response relationship for carcinogenicity of hexavalent chromium. These results are acknowledged to be the preferred approach of the RAC and SEAC and therefore have been used as a methodology for the calculation of work cancer risks in this socio-economic analysis.

The following steps are therefore necessary to complete the health impact assessment:

1 – Assessment of worker exposure (actual measurements)

2 – Estimation of additional cancer deaths relative to the baseline lifetime risk

3 – Estimation of additional non-fatal cancer based on survival rate statistics

4 – Monetary valuation of fatal and non-fatal cancer risks

Following the worst-case approach, the combined worker exposure values from the corresponding chemical safety report, section 10, are used to make the assessment of health impacts. Following the ECHA methodology where the applicant only provides data for

the exposure to the inhalable particulate fraction, it will be assumed that all particles were in the respirable size range and only lung cancer need be considered.

For the lung cancer calculation, excess lifetime risk (ELR) is defined as the additional risk of dying from cancer due to exposure of toxic substances incurred over the lifetime of an individual. From the ECHA RAC the unit of occupational excess lifetime mortality risk is 4 X 10^{-3} per μg Cr(VI)/m^3

Table 2: Excess lung cancer mortality risk to workers covered by this application

A	Inhalation exposure weighted average μg/m^3	4.875
B	Excess risk unit coefficient	4 x 10^{-3} per μg/m^3
C	Excess risk for 40 years (A x B)	18.7 x 10^{-3}
D	Excess risk per year (C/40)	0.465 x 10^{-3}

E	Number of workers exposed	204
F	Total annual excess risk (number of cases)	0.0949

The individual development of cancer may be fatal or non-fatal whereas the dose response function considers only fatal cancer. It therefore follows that the excess risk of cancer is higher than the excess risk of fatal cancer.

According to Cancer Research UK the following table can be developed:

Table 3: Age-standardised, five-year survival rates for lung cancer in the UK, 2013-2017

Relative cumulative survival	Non-fatal/ fatal ratio
16.2	0.193

This means that for every fatal case of lung cancer, there is an additional 0.193 non-fatal cases in the UK. This equates to 0.0003 non-fatal cancer cases associated with this application.

Table 4: Values for fatal and non-fatal cancer taken from ECHA Guidance using December 2003 exchange rate of €1.42 / £1

	2003	GDP factor	2020
Value of statistical life	£740,845	133.95	£992,362
Value of statistical life (sensitivity)	£1,590,141		£2,129,994
Value of cancer morbidity	£370,423		£496,181
Value of cancer morbidity (sensitivity)	£795,070		£1,064,997
Value of cancer fatality	£1,111,268		£1,488,543
Value of cancer fatality (sensitivity)	£2,385,211		£3,194,990

The GDP factor is the change in UK GDP between 2003 and 2020 as per the UK Office for National Statistics and allows for inflationary impacts to be included in the assessment.

Table 5: Estimated monetary value of annual risk of lung cancer from chromium trioxide exposure for this application.

	All sites combined
Fatal cancer risk per year	0.0949
Annual cost of fatal cancer risk Per case £1,488,543 Sensitivity £3,194,990	 £141,267.73 £303,204.55
Non-fatal proportion Non-fatal cancer risk per year Annual cost of non-fatal cancer risk Per case £496,181 Sensitivity £1,064,997	0.193 0.0183 £9,080.11 £19,489.46
Total annual cost of cancer Sensitivity	£150,342.84 £322,694.01

These figures used the same methodology of those submitted by Grohe AG who were granted a 12-year review period for their authorisation.

Given that the results show no increased risk over that of the General Population and that there are no emissions to atmosphere, the implications of a non-use scenario will only affect the applicants and their customers.

Similarly, the continued-use scenario does not give rise to any additional economic burden toward health or environment.

4.3 Non-use scenario

If authorisation is refused, there would be an immediate loss of business and the applicants will be unable to continue trading. This will place the workers at immediate risk of unemployment and the applicants with significant costs associated with chemical disposals, redundancy, asset disposal and premises sale.

4.3.1 Summary of the consequences of non-use

(data and monetary values below refer only to 13 companies in "Technical Components" group)

In the non-use scenario, the applicants will cease trading and customers will resort to purchasing the same services (chromium trioxide plating) from overseas i.e., outside of The UK and The EU resulting in increasing the UK's trade deficit without removing the substance from Global use.

Larger customers with a regular requirement for the process may also take the decision to re-locate to the geographical supply base i.e., Off-shoring.

The job losses would total 307 from the applicants with an added risk within their customers employee base of 45327 staff.

The short-term effect to the economy would be the loss of approximately £20.5M GDP (per annum) and the contribution to UK Treasury from taxes, etc.

In the medium-term, should customers decide to relocate, the loss to UK GDP would be more than £1,025M (based on "top 5" turnover).

The economic effect on the suppliers, of chromium trioxide, to the applicants cannot be quantified in this report.

The Group members in this consortium able to research, and/or trial, potential alternatives have submitted samples and consulted with their customers.

The customer responses to these are (ref. Section 3.2):

"Over 50% of our chrome plated parts…before being exported to the US."

and *"finish needs to match identical plated components supplied to our customer in the US in both colour and corrosion performance"*

"shipped to Sweden, and these also need to match other parts that are sourced from the far east."

"Trivalent Chrome processes do not give the required corrosion protection at the weld points, leading to discolouration at the joint"

"tried PVD coatings like Nitron MC (tungsten/carbide deposition) but the market rejected this due to after-market service/sharpening"

and *"this technology is cost-prohibitive for us to use"*

"tried trivalent chrome, but this didn't offer the hardwearing and protection our products require in such a harsh environment"

4.3.2 Identification of plausible non-use scenarios

Non-use Scenario 1

Shut down of chrome plating process, resulting in company closure.

Sections 3.3.1.4, 3.3.2.4 and 3.3.3.4 detail the technical performance of each of the potential alternatives and, while some of the requirements are met, there are none that meet the 'basic' criteria of visual appearance (colour) and wear resistance.

These are critical requirements for this market sector hence, section 3.4 concludes that "none of them are currently considered to be viable alternatives for this particular use."

The customer "demand" is for technical performance, colour consistency, in addition to colour matching to existing parts and other parts available from overseas suppliers.

As there is no alternative process, the existing chromium trioxide facilities will close, and staff will be redundant.

The company must dispose of all materials, using specialist contractors to handle the hazardous waste thereby, incurring unrecoverable costs. The process facility is then dismantled and disposed to waste/scrap recovery incurring further specialist contractor cost because of the contaminated equipment.

Removal and clean-up costs reduce company balance sheet value affecting the ability to pay both statutory and commercial creditors and, possibly, staff redundancy payments.

Any Service Level Agreements (SLA) that cannot be satisfied will be subject to contingent cost claims from the customers so reducing the value of the remaining income from invoices issued prior to closure.

Non-use Scenario 2

Change to worse performing alternative.

Section 3.3.1 details the trivalent chrome process, its operation, and its technical characteristics.

Trivalent chrome processes are unstable and energy intensive. Using this process incurs additional analytic and control staff, consumes additional energy, and gives inconsistent finishes.

These result in increased payroll cost, increased energy cost and re-processing cost (if possible). Disposal of existing chromium trioxide is done by specialist contractors. Installation of additional equipment relative to trivalent chrome processing is done – involving closure of the production facility and addition of bunding area, tanks, controls, services, and utilities.

Loss of business due to stoppage of process will occur in the **short-term**.

On restart, consistency of finished product varies, and 'colour' does not match requirement resulting in customer rejects and rework cost and/or scrappage of components – incurring replacement cost.

Medium-term, loss of business due to quality and throughput failures. Reduction in staffing levels due to loss of business.

Customers source “original” finish (chromium trioxide) from available sources (overseas).

Long-term, cost burden and inability to supply consistent product that performs both technically and aesthetically result in loss of customers and significant reputational damage.

Customers source “original” finish (chromium trioxide) from available sources (overseas).

This results in closure of uneconomic process following financial losses due to failures in quality and delivery.

Staff are redundant when process stops.

Disposal and removal cost incurred. Business closes.

4.3.3 Conclusion on the most likely non-use scenario

NuS 2 is very unlikely to occur as the applicants do not have the financial capacity, floorspace or number of staff required to install a process which is known to be unacceptable.

The most likely NuS is scenario 1 i.e., Off-shoring of process and closure of applicants’ business.

Immediate effect on local economy with added potential of larger customers re-locating to supply base geographic area and affecting UK GDP.

This market sector is very demanding and are concentrated on achieving a long-lasting, aesthetically acceptable and ‘matching’ product. It is not uncommon to replace parts with ‘new’ and those that are chromium plated must be a visual ‘match’ to the rest of the parts.

This fact alone, determines that the customer will demand the chromium trioxide process and this will incur transport costs and delays resulting from extended supply routes – these additional costs and delays will result in significantly inflated costs.

Sourcing this process overseas will have a negative impact environmentally resulting from the emissions from transport and will “export” the chromium trioxide work to less well-regulated areas.

4.4 Societal costs associated with non-use

In the continued use scenario, it is expected that there will be some additional costs associated with testing, reporting and control systems resulting from conditions applied to the authorisation approval. Although this will be contingent cost to the applicants it is very likely to be passed through the supply chain in the form of price increases therefore would not be additional cost to the applicants.

In the Business as Usual (BaU) case there would be no effect on the economics of the process or product. Employment would continue at the current levels and contributions to the local economy and national GDP would be stable.

As there are no increased health effects to either the workers or the general population, there would be no economic effect to the health or social services.

In the medium to longer term, it is expected that business levels will increase. This will result in additional turnover and employment in the supply chain thereby increasing the economic contribution of the sector.

Confidentiality concerns from customers makes it extremely difficult to obtain quantitative information about their detailed spend or the value contribution to turnover from the plating service. However, the approximation used for this report is 2% of customers' product selling cost (turnover). As the share of the customers sales value resulting from chromium plated parts cannot be quantified, the combined turnover value of the applicants (£20.54M) is used to calculate the contribution to GDP value.

Thereby: **£20.54M/2% = £1,025M GDP value.**

In the non-use scenario the sales value (£20.54M GDP) would be lost because of closure of the applicant businesses. Any export value (not quantified) would be lost and the remainder of the estimated £1,025M GDP value would be replaced by import cost.

This would effectively more than double the effect to the UK trade balance as there would be transportation and additional inventory costs to be factored into the cost of supply.

As this is a demand driven product, it is not possible to quantify the financial impact on the customer supply chain.

In this case the cost calculations take account of the unemployment costs associated with the closure of the applicants' businesses. Because of the numerous companies involved and the wide age demographic that is likely, it is assumed the average age of the workers to be 40 i.e. 20 years old = newly skilled, 60(+) years old highly skilled therefore assume the mid-value as the average for the purpose of this assessment.

It is assumed that all those workers made redundant as a result of the non-use scenario and closure of the applicants businesses would experience a period of temporary unemployment. This assumption is based on the understanding that the workers are generally highly skilled and therefore likely to regain employment within a relatively short period.

Using a conservative approach, the estimated unemployment periods and resultant costs will be calculated using data published by the Office for National Statistics (ONS) 14 June 2022. These data show a 'total' unemployment rate of 3.9% but, a rate of 27.4% for those aged 16-64.

The 'total' figure is used so that there is no bias to the resultant costs even though workers in this industry are predominantly male. Further, it is assumed that re-employment within the first year will be within 3 months and that the rate of re-employment is constant year-on-year and that re-employment is achieved at the mid-point of the second and subsequent years i.e. 6 months unemployed in that year.

It can be seen from table 6 that it is expected that all workers will be re-employed by 4 years after redundancy.

Table 6: Annual unemployed by year following closure

Average salary cost = £31772 (ref. ONS April 2021)

		Social cost	Lost Earnings
Permanent Workers		(£77/week – 2022)	(net avg salary)
307	2023	£559,559	£3,880,578
84	2024	£214,214	£1,485,588
23	2025	£60,060	£416,520
7	2026	£16,016	£111,072
1	2027	£2,002	£13,884
TOTALS		**£851,851**	**£5,907,642**

In all cases, conservative estimations and assumptions have been used to ensure that the socio-economic impacts of the non-use scenario have not been overestimated. Further, there are likely to be a number of additional negative effects which have not been quantified or monetised due to a lack of suitable data and/or information. These include temporary reductions in output and employment in the applicants' supply chains and in the local economies surrounding the affected manufacturing sites.

4.4.1 Economic impacts on applicants

In the non-use scenario, the applicants' businesses will close resulting in total loss of profit but will remove cost of manufacturing i.e., raw material, utilities, payroll, etc.

However, there will be costs incurred because of redundancy payments (unquantifiable. Values subject to workers age, service, etc.), disposal of residual stock and process chemicals (unquantifiable. Subject to analysis and volumes).

Also, disposal of fixed assets (process equipment, etc.) is likely to be for 'scrap' value only as there will be no market in the UK for this equipment. Financial value of this scrap will result in a reduction of balance sheet values for fixed assets.

Once chemical disposal, clean-up and asset disposal are complete, the property (buildings & land) can be sold. Current industrial property values are relatively high (2022) but, in this scenario, there will be numerous properties available which may serve to depress the market value.

Again, for the purposes of this assessment, the costs are assumed to equal the reduction in manufacturing cost, the balance sheet value and potential return on asset sale.

As the applicant will need to finance the disposals and clean-up costs, the probability is that they will enter Administration or Liquidation putting the immediate burden of redundancy cost on to the Public Purse.

4.4.2 Economic impacts on the supply chain

In the non-use scenario there will be an immediate effect on the customer base in that the only option will be to purchase the same goods and services from outside the UK/EU.

This will increase lead-time, costs and reduced service levels.

Cost increases will be passed on to their customers who will already be suffering delayed supply and possibly result in cancellation of supply contracts and, what are currently exports of goods and services will probably be lost to the overseas suppliers who will deal directly with the export customers.

4.4.3 Economic impacts on competitors

While there is some use of alternative processes within the UK these have been dismissed by this market sector as being unacceptable.

This means there would be no economic advantage achieved by any UK based competitor who are using an alternative. The entire value of the customer base will be lost to foreign suppliers.

4.4.4 Wider socio-economic impacts

In addition to the socio-economic impacts described in the previous sections, the non-use scenarios might be associated with wider economic impacts. These include possible impacts on government tax receipts. These are transfers from workers, consumers, and capital owners to taxpayers, and are effectively included in the figures presented above, which are defined in terms of total economic value. Taxes are a transfer of a portion of that value between parties — the distributional aspects (the extent to which part of these values are transferred to taxpayers) are not considered in detail.

There might also be impacts on local economic activity and development because of the non-use scenarios, but these impacts are expected to be limited.

There will clearly be an impact on international trade, with UK-based production being replaced partly or wholly by output produced outside the UK/EU. This is detailed in the previous sections and would be a combination of the lost output value from the applicants plus additional freight costs and the lost export values of goods and services from the customers trading values.

4.4.5 Compilation of socio-economic impacts

Table 7: Societal costs associated with non-use.

Description of major impacts	**Monetised/quantitatively assessed/qualitatively assessed impacts**
1. Monetised impacts	**£ [per year[1]] [Over x years]**
Direct business loss due to closure	£20.5M
Potential supply chain impact	£1,025M
Social cost of unemployment	£851,851 over 4 year period
Cost of lost wages	£5,907,642 over 4 year period
Sum of monetised impacts	£1,052,259,493
2. Additional quantitatively assessed impacts	**[Per year] [Over x years]**
	Not applicable
3. Additional qualitatively assessed impacts	
	Not applicable

4.5 Combined impact assessment

Table 8: Societal costs of non-use and risks of continued use.

Societal costs of non-use		**Risks of continued use**	
Economic impacts (annual) Social impacts (over 4 years – declining value per year) ref table 4	£20,500,000 + £6,759,493	Monetised excess risks to directly and indirectly exposed workers (Annual values)	£150,342.84 £322,694.01 (higher bound sensitivity)
Off-shoring by supply chain (annual)	£1.025Bn	Monetised excess risks to the general population	No risk to general population
Qualitatively assessed impacts	Not applicable	Qualitatively assessed risks	No direct emissions to the environment

Therefore, the total costs of the non-use scenario are estimated at £88.76M over the 4-year period from the implementation date. The added value lost, to UK GDP, by the supply chain offshoring manufacture would be £4.1Bn over the same 4-year period. The total benefit of the non-use scenario i.e., avoiding the direct cost to human health as a result of exposure to Cr(VI) is estimated at £0.61M over the same period, with a value of £1.291M as an upper bound sensitivity.

It can be seen, then, that the costs of non-use clearly outweigh the benefits by several orders of magnitude.

Costs of non-use per unit of release.

Not applicable

4.6 Sensitivity analysis

The societal cost of continued use is severely increased in the calculations because of the WEL value used where results are reported as <0.025mg/m^3 and where reports have not been made available.

Assuming analysis levels to be similar to those reported as 'actual' values, the societal costs are expected to reduce by a factor of 10 as a minimum.

In this circumstance, the cost benefits of continued use increase by a significant factor.

4.7 Information to support for the review period

This group of applicants consider a review period of 12 years to be appropriate for the use of Cr(VI) in the coating of "Technical Components" to create a coating which provides specific performance characteristics, matches existing parts and those supplied from other sources.

- The market for these products is dominated by Cr(VI) plated products because of their superior performance, long lifetime in use and aesthetic quality in comparison to the available alternatives.
- The available alternatives to Cr(VI)-plated products have critical performance weaknesses which explain why they meet only niche requirements in this sector. While these critical performance weaknesses exist, any future lack of availability of UK-manufactured Cr(VI)-plated products in the UK will be met through imports of Cr(VI)-plated products (particularly from China), not through any substitution for non-chrome alternatives;
- As a result, until these critical performance weaknesses have been overcome, it will never be economically viable for the applicants to stop producing Cr(VI)-plated products in favour of these alternatives, and the non-use scenario will continue to be the closure of the applicants chrome businesses and with the additional risk of the supply chain (customers) relocating to a country outside of the UK/EU to an available geographic supply-base;
- The costs of these closures and relocation of the supply-base are extremely high and will continue to be so;

- In comparison, the risks of the applicants continued use of Cr(VI) are very low and will continue to be so. These risks will not be avoided in the non-use scenario, but simply shifted from the UK to another country outside of the UK/EU;
- Within the wider industry, and material suppliers, research into alternatives to Cr(VI)-based electroplating has been carried out for decades to address the existing performance weaknesses of alternatives, and it continues to do so. However, the performance advantages of Cr(VI) are very strong, and major innovations and developments would be necessary to overcome them. Industry has initiated joint research with academic groups in an attempt to address these weaknesses, but no significant success is expected within the foreseeable future;
- Even if a viable alternative of equivalent performance to Cr(VI) was to become available, it would still take several years to develop into a marketable product, to industrialise the production process, and to implement the necessary process changes for large-scale manufacture. These changes are expected to be highly costly. In addition, there will still be a need to provide continued support to customers of existing Cr(VI) products, in terms of spares, etc., in line with the market demands.
- The conclusion of this assessment is that research and development efforts made in the past and ongoing efforts made by Industry have not led and will not lead to the development of a suitable alternative that could be available within the normal review period. The remaining risks are low and the socio-economic benefits are high (around 20 times), both estimated on a highly conservative basis, and there is clear evidence that this balance is not likely to change in the next 12 years. Taking this into consideration, the applicants argue that a `long' review period of twelve (12) years is appropriate.

5 CONCLUSION

Section 4.7 (above) details the reasons why the applicants recommend authorisation for continued use of Cr(VI) [chromium trioxide] and this authorisation to be granted with a review period of 12 years.

6 REFERENCES

1 BS EN ISO 1456 published by British Standards Institute ISBN 978 0 580 609541
2 Application for authorisation for the continued use of chromium trioxide produced by the Chromium Trioxide Authorisation Consortium (CTAC) made up of the key producers and importers of chromium trioxide and wet process chemistry for electroplating.
3 ALARP – Health & Safety Executive principle – As Low As Reasonably Practicable. This involves weighing a risk against the trouble, time and money needed to control it. It describes the level to which the Health & Safety Executive expect to see workplace risks controlled.
4 Survey on technical and economic feasibility of the available alternatives for chromium trioxide on the market in hard/functional and decorative chrome plating. A report produced by the German Federal Institute for Occupational Safety & Health (BAuA)