ANALYSIS OF ALTERNATIVES

and

SOCIO-ECONOMIC ANALYSIS

Legal names of applicant:	C&E Plating Limited
Submitted by:	C&E Plating Limited
Date:	1st November 2023
Substance:	Chromium trioxide, EC/List no.215-607-8, CAS no.1333-82-0
Use title:	Functional chrome-plating with decorative character
Use number:	1

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DECLARATION

We, the Applicant, are aware of the fact that further evidence might be requested by HSE 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 (1st November 2023), 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.

Signature: Date, Place: 01.11.23. Solihull.

1. SUMMARY

- The two companies involved in this application, WH Darby Ltd and C&E Plating Ltd, are, respectively, manufacturer of badges, jewellery and other metallic objects, and provider of plating services. C&E Plating (the applicant) provides plating in a range of finishes including chrome, using technology based on chromium trioxide. This technology provides a high quality glossy and hard-wearing finish to the object plated. The products which are plated and supplied include automotive badges, civic and state regalia, electrical fittings, jewellery and clothing accessories.
- The applicant has reviewed previous applications for authorisation and consulted with its supplier regarding alternatives to chromium trioxide-based plating. It has also test-plated an object for a prospective client using a plating technology based on chromium (III) oxide. This test was rejected by the client.
- This rejection confirms the results of the application review that there is currently no suitable alternative for chrome-plating based on chromium trioxide. This is for three principal reasons – alternative technologies do not provide a finish which is as durable, resistant to corrosion and colour-stable; the alternative technologies are all significantly more expensive; the most likely alternative (based on chromium (III) oxide) is also not clearly safer than the existing technology.
- Claim 1 [redacted]
- If the application is granted, the companies will continue to use chromium trioxide to provide high quality plating and plated products to clients. They are too small (fewer than 50 employees combined) to be able to undertake significant R&D into alternatives themselves but will continue to liaise with their supplier and clients and monitor the development of new technologies. However, as subcontractors, both companies are dependent on the preferences of their clients and exist to provide the services and products which those clients demand.
- If the application is not granted, the companies expect that the chrome-plating business would be closed down and WH Darby's automotive business would be lost. This would result in a significant reduction in turnover and profits, and necessitate a number of redundancies.
- The Chemical Safety Report indicates that risks to workers are well controlled, and risk to 'man via environment' are negligible. The costs of the non-use scenario are estimated to outweigh the risks of continued use by a factor of Claim 4 [redacted] This result is robust to reasonable sensitivity analysis.
- The applicant requests a review period for this authorisation of 12 years.

2. AIMS AND SCOPE

C&E Plating Limited (hereafter, 'C&E') is a company located in Birmingham, UK, providing high quality plating services in a range of finishes.[1] The company was established in 1951 in the Birmingham Jewellery Quarter, and has since developed a reputation for electroplating of superior quality and craftsmanship. The company provides plating in gold,

[1] https://ceplating.co.uk/

chrome, rhodium, bronze, copper, silver and other finishes, for manufacturers supplying electrical components, collectibles (e.g. medals and trophies), jewellery, audio equipment and automotives, as well as bespoke plating for private individuals.

WH Darby Limited (hereafter, 'WHD') is one of the UK's premier manufacturers of jewels, medals, chains of office and badges. Through its Vaughtons brand, it also provides automotive accessories, electrical fittings, sanitaryware and other products. The company was originally founded in 1886 as die-sinkers, and badge- and medal-makers.[2] C&E is part of the same group as WHD, and is the supplier of plating services to WHD. As such, WHD is a major client of C&E, and a joint applicant with C&E. However, all plating with chrome trioxide is undertaken by C&E alone.

C&E uses chromium trioxide (hereafter called Cr6) for electroplating to provide articles with a high quality, durable surface, with a shiny (often, but not always, decorative) chromium finish. Cr6 is classified as Carcinogen cat 1A and Mutagen cat 1B. It therefore meets the criteria of Article 57(a) and (b) of Regulation (EC) No 1907/2006 (EU REACH) as a Substance of Very High Concern (SVHC). It was included in the list of substances subject to authorisation (Annex XIV, entry 16) with an original sunset date of 21st of September 2017.

Table 1: Substance of Very High Concern relevant to this analysis

Substance	**Intrinsic property(ies)**	**EU Latest Application Date[2] and Sunset Date**	**UK Latest Application Date and Sunset date[3]**
Chromium trioxide (entry 16) EC No: 215-607-8 CAS No: 1333-82-0	Carcinogenic 1A Mutagenic 1B	21 March 2016, 21 Sept. 2017	30 June 2022

When the UK left the EU on 1st January 2021, EU REACH was adopted into UK law and is now known as UK REACH. On this date, transitional arrangements came into place for users of SVHCs previously covered by EU REACH authorisations. In the current case, the applicant's use of Cr6 was covered by the CTACSub application, Use 3 (ECHA application ID 0032-003). Under the transitional arrangements, the applicant's use was allowed to continue, and the applicant was required to submit their own authorisation application (or be covered by another's authorisation application) by 30th June 2022 (Table 1).

It was the intention of the applicant to join up with the Surface Engineering Association Chromium Trioxide Authorisation Consortium (SEA-CTAC), to be part of their application for authorisation (AfA) for the use of Cr6 under UK REACH.[3] This application was submitted before the Latest Application Date of 30th June 2022 but, due to administrative oversight, the applicant was not included in the consortium. C&E has been allowed to continue its chrome-plating activities on certain conditions set by HSE, including that an AfA for this use should be submitted to HSE by 1st November 2023. This document is the combined analysis of alternatives (AoA) and socio-economic analysis (SEA) of that application.

The objectives of this AoA/SEA are:

[2] Die-sinking is the process of engraving steel block for stamping designs on coins, medals etc.

[3] https://consultations.hse.gov.uk/crd-reach/afa024-01-cro3/

1. to describe the applicant's use of Cr6 and the commercial activities which it supports;
2. to assess the applicant's alternatives to Cr6 and what the impacts would be of adopting them;
3. to identify what the companie would do if they were unable to continue using Cr6, and what the impacts of that course of action would be;
4. to assess the risks to human health of the applicant's continued use of Cr6;
5. to compare 3 and 4 to demonstrate whether the applicant's continued use of Cr6 is justified from a societal perspective;
6. to provide information relevant for setting a review period for the authorisation, if granted;
7. to describe what the applicant will do to pursue substitution in future if this application is granted.

Both companies are UK businesses and their commercial activities are primarily domestic. Impacts of the applied-for use and non-use scenarios are also primarily domestic; any international impacts are expected to be minor. The geographical boundaries of the analysis are therefore GB. The primary temporal boundary is 12 years from the expected decision date on this application. This is sufficient to cover expected societal impacts – long-term health impacts (i.e. cancer risk) are dealt with through discounting. A standard UK discount rate of 3.5% is used throughout.

3. ANALYSIS OF ALTERNATIVES

3.1. SVHC use applied for

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

Reasons for using Cr6 as a surface-coating technology

C&E is a contract plater of metal pieces for a range of clients and sectors. C&E can provide plating in several finishes, including gold, bronze, copper, nickel and chrome, according to client requirements. Pieces are generally made of brass (particularly 'gilding metal', a type of brass with a high copper content), and always metal, rather than plastic. Pieces to be plated by C&E are manufactured by one of the other companies in the WHD group, or are supplied directly by clients themselves. C&E and the other WHD group companies have a long history of craftsmanship and exceptional quality, and this is reflected in the types of clients and products it handles. Automotive clients are holders of prestige marques such as Aston Martin.[4] Other clients supply military accessories and state regalia by royal appointment. Others are simply suppliers to high-end markets where customers expect and pay for premium quality.

A chrome-plated finish can be chosen by a client for a variety of reasons. Table 2 lists a set of performance requirements which a surface can be required to meet, and a brief explanation of why Cr6 surfaces are chosen in response. In summary, Cr6 surfaces can be

[4] https://www.astonmartinlagonda.com/

chosen for both aesthetic and technical reasons. When applied with high levels of technical skill (as possessed by C&E), Cr6 surfaces can possess strong aesthetic qualities, with good surface glossiness, colour and smoothness, free from blemishes. This makes them suitable for products meant for high-end markets and applications. Cr6 surfaces are also highly consistent over time and between batches, as well as resistant to corrosion, chemicals, wear and abrasion, which makes them suitable for applications where the surface might be subject to physical or chemical attack during the course of the product lifetime.

Table 2 Surface performance requirements and suitability of Cr6

Requirement	**Description**
Corrosion resistance	Surface must be resistant to corrosion because of the environment and/or use of the product, which can reduce product service quality and life through breakage, degradation or poor aesthetics. For instance, electrical connections can be degraded by corrosion on the connection surfaces, so Cr6 is often used to ensure a good connection is maintained over a long service life (e.g. plugs and connectors for hi-fi equipment).
Chemical resistance	Surface must be resistant to chemicals to which the product is exposed through the course of its service life, which would otherwise affect the integrity of the coating and aesthetic quality. For instance, cleaning agents are used on sanitaryware like taps so Cr6 surfaces are often used because they are highly resistant to aggressive chemicals.
Hardness and resistance to wear and abrasion	Surface must resist damage from normal use, which can reduce service life and aesthetics and also lead to other problems such as corrosion. For instance, automotive components can be prone to scratching and chipping as a result of impacts from stones and other objects on the road. Cr6 surfaces have a high degree of hardness which reduces scratching and chipping.
Colour and shine stability and consistency	Surface should be resistant to discolouration and loss of shine over time, which can reduce product aesthetics and value. Colour and shine should also be consistent across different items and product components, to permit batch-mixing and to maintain aesthetics and perceived value. Cr6 surfaces are highly stable over time and consistent across batches.
Surface consistency and smoothness	Surface should be consistent, smooth without blemishes or other faults, which can reduce product aesthetics and value, and lead to rejections. Cr6 surfaces can be highly consistent, smooth and blemish-free.
Regulations and standards	Surface must comply with technical specifications and regulations at international, national, industry and/or business level. These specifications and regulations are often technical measures and tests of the above performance criteria.

Client and customer performance requirements at C&E and WHD

When setting quality and performance standards for client projects, C&E and WHD outputs are governed by a Part Quality Standard (PQS) established for each project and part to be plated. The PQS is agreed with the client and used by the C&E and WHD inspections departments to check outputs and ensure quality matches requirements. The PQS covers the dimensional and visual requirements of every part supplied. Providing a reference source ensures that a product is only passed and delivered to agreed client requirements.

In addition to the PQS, a client agreement can include specific standards and/or tests which a part must pass to meet client requirements. For instance, the C&E agreement with [redacted] specifies the following:

1. Appearance of the part must comply with the Part Quality Standard (PQS)

[redacted] Alkali resistance [redacted]
[redacted] coating performance [redacted]
[redacted] Salt spray [redacted]
[redacted] Impact resistance [redacted]

The PQS specifies what appearance defects are acceptable (and unacceptable) for each part, [redacted]

[redacted]

Quality assurance and penalties for non-compliance

Every piece plated by C&E and supplied by WHD is subject to detailed inspection by trained staff, at least twice, to ensure it means the PQS or other quality standard agreed with the client. Part quality is measured and reported as part of a weekly/monthly scrap analysis reports. Additionally, any rework and stripping required to be conducted by C&E is recorded. Training of inspection staff is conducted and refreshed every 12 months. Clients will also inspect part quality and return any which do not meet standards, and customers might also report quality standards through (e.g.) warranty claims. [redacted]

If an article does not meet the agreed standards, C&E (and possibly its clients within the WHD group) are likely to face a range of accelerating penalties. Those penalties are specific to the contract which in turn is specific to the client and their demands. Whilst the penalties are not always stated, potential impact can be inferred. For example, one of the applicant's 'smaller' overseas clients demands a number of quality, acceptance and warranty requirements such as:

- "Goods are received conforming to agreed specification and are free from defects." (This will depend on the original agreement between the applicant, the client and associated PQS.)

- "Should non-conforming parts be supplied, [the applicant] will be responsible for restoring supply and the settlement of any damages incurred."
- "Should [the applicant] be unable to deliver parts as per agreed schedule, [they] will be liable for a fine corresponding to 5% of the total order value, up to a maximum of 20%."
- "Should any warranty issues be reported, [the applicant] is to protect [the client] from any blame and compensate should damages be suffered."

Within the automotive sector, fines may be given should a quality issue prevent supply, which is known as a 'line stop'. Whilst fines are not generally stated explicitly, it would be expected to be based on the time the line was down and the value lost during that time. Due to the speed of manufacture, this value can quickly accumulate and hence anything but the shortest period of downtime would represent a significant danger to the applicant's business.

The C&E Cr6 plating process

The Cr6 plating process is similar to those used by other small 'artisan' companies undertaking plating by hand. In the case of the companies' biggest combined customer Claim 2 the gilded metal badges are received by C&E from WHD Claim 2 [redacted]

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

As already described, C&E provide chrome-plating to a wide range of different types of products, for clients directly or via WHD. These include car badges, medals and civic and state regalia, clothing accessories, electrical components, door handles, window brackets and even parts for sporrans. C&E's single largest customer for Cr6-plating in recent years has Claim 2 and this business has all been related to the manufacture and supply Claim 2 [redacted]

Some examples products are presented in the following figures: premium car marque badges (Figure 2), chrome electrical fittings (Figure 1), chrome clothing accessories (Figure 3) and chrome civic and state regalia parts (Figure 4).

Figure 2 Premium marque car badges

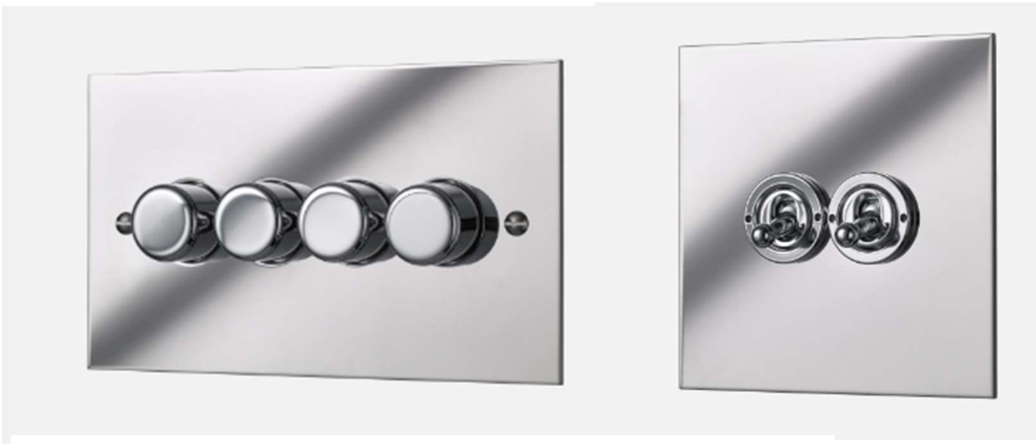

Figure 1 Chrome electrical fittings

Figure 3 Chrome clothing accessories (e.g. cufflinks, buttons)

Figure 4 Civic and state regalia (e.g. mace parts, chains of office)

It should be recognised that the companies' markets are connected and chrome- and non-chrome businesses cannot necessarily be treated as separate. As already explained, Claim 3 [redacted] This is because WHD manufactures the badges which are subsequently plated by C&E, Claim 3 [redacted] If C&E was to close its Cr6 plating capability, it would lose not only the sales (profits) associated with its plating, but WHD would also be at risk of losing the sales (profits) associated with its badge manufacturing.

Similarly, C&E's Claim 3 [redacted] Chrome is only a small part of this business, and other finishes such as brushed nickel, antique bronze etc are more important. However, if C&E were unable to continue supplying chrome finishes, Claim 3 [redacted] drop chrome from its product line or find another plater just for chrome. Alternatively, the client could simply move all of its business to a different plater who could provide the whole range of finishes it requires.

As such, therefore, the WHD group of companies acts very much like a 'one-stop shop' for a lot if its clients – providing design of items, manufacture of them, plating and finishing all under the same 'corporate roof'. There are several companies in the Birmingham area, and elsewhere, whom C&E would consider competitors, such as:

Claim 2 [redacted]
Claim 2 [redacted]
Claim 2 [redacted]

Claim 2
Claim 2

C&E sees itself as distinguished by its high quality range of finishes, and small and personal operation which permits a more tailored approach and fast turnaround. C&E is not unique in providing this type of service, but it certainly limits the number of firms considered genuine alternatives for clients. WHD's competitors are fewer, which might be expected given the relatively more specialised products and markets WHD supplies compared with the more 'transferable' services offered by C&E, and would include:

Claim 2
Claim 2
Claim 2

These companies do not just service the same (or similar) markets but in some cases the same (or similar) parts for the same clients. Clients might do this as a reflection of individual subcontractor capabilities but also to provide 'redundancy' and insurance against possible supply disruption. It can also provide 'internal competition' and a way of judging supplier performance. It also underlines how the C&E and WHD (and any other companies who are essentially service suppliers) are fundamentally limited in terms of their ability to make changes to their processes or products without the full agreement of their clients – who can simply switch to alternative suppliers if they do not accept a change.

3.1.3. Annual volume of the SVHC used

Based on discussions with its supplier and consideration of the likely direction of the business, C&E expected to use a maximum of Claim 2 less than 1 tonne per year if this authorisation is granted.

3.2. Efforts made to identify alternatives

3.2.1. Research and development

C&E is a downstream user of chromium-plating technology provided by its supplier. As a downstream user for decades, the company has developed significant expertise in applying this technology to the plating of products supplied by its clients, and has a reputation for extremely high quality. However, it is not the ultimate owner of the technology and, with a workforce of fewer than 15 people, it is not in a position to conduct scientific research and development (R&D) to find alternatives to chromium trioxide for the purposes of obtaining a hard-wearing, smooth and shiny metallic finish. Rather, C&E is reliant on technology suppliers providing alternative processes and products obtained from those processes for it to assess. C&E's activities have therefore focused more on staying alert to developments in chrome-plating technology. It did gain experience of products obtained using alternative technologies Claim 1 and this experience is described below.

3.2.2. Consultations with customers and suppliers of alternatives

It should be noted that C&E does not manufacture products itself, but provides electroplating services whereby clients can obtain the finish they want on products they supply. C&E is therefore a 'job plater', and provides services to its clients' specifications and requirements.

Claim 1 [redacted] C&E investigated the use of Cr3-based Claim 1 [redacted] It plated some components for a prospective automotive client Claim 2 [redacted] using this technology, subjected them to the required testing, and provided them to the client for review.

3.2.3. Data searches

As part of preparing this AoA/SEA, the applicant haS reviewed the considerable body of information which has been reported over recent years in AfAs submitted to ECHA for the continued use of chromium trioxide in electroplating. This is by far the most extensive and up-to-date evaluation of alternative plating technologies available, probably in the world. As of July 2023, there have been over 40 AfAs submitted to ECHA for the use of chromium trioxide for chrome-plating with decorative character, the first in May 2015 and the latest (published on the ECHA website) in February 2023. Together, these applications provide a detailed, dynamic assessment of the development of alternatives to chromium trioxide-based plating for the applicant's use. The applicant is also aware of AfAs for this use which have been submitted to HSE under UK REACH, including that of the consortium which they had originally hoped to be part of, some members of which are similar companies to the applicant in terms of their size, market-positioning etc.

3.2.4. Identification of alternatives

A number of potential alternatives have been considered in previous AfAs for functional chrome-plating with decorative character. These include:

- Chromium (III) chloride plating on nickel (hereafter called Cr3)
- Chromium (III) sulphate plating on white bronze
- Physical vapour deposition (PVD)
- Chemical vapour deposition (CVD)
- Lacquering/painting, powder-coating etc
- Stainless steel

Alternatives which result in a finish which is significantly different from the shiny chrome finish obtained with Cr6 (e.g. lacquering, powder-coating) will not be accepted by C&E's clients and hence are rejected. PVD and CVD have been rejected by other platers on the grounds that they are extremely expensive and result in a finish which is not sufficiently resistant to corrosion or wear. Stainless steel is not suitable because, although the finish can be comparable to chrome, the material itself cannot be cast or otherwise fashioned into the intricate shapes and designs, or have vitreous enamel laid onto it, which characterise the types of articles C&E is commissioned to plate.

As a result, the only alternative which has received serious consideration by the functional-decorative plating sector is one based on Cr3. C&E gained some practical experience of a Cr3-based alternative. Claim 1 [redacted].which is explained as part of the assessment of this alternative in the next section.

In addition to technical alternatives to chrome-plating (i.e. other coating technologies), C&E would also have the option of complying with a requirement to stop its use of Cr6 in GB by:

- Contracting out its plating to another plater (authorised in GB or EU, or outside)
- Moving out of GB to a location where Cr6 can still be used without authorisation
- Closing down its plating operations

These 'managerial' alternatives are considered in Section 4.3.

3.2.5. Shortlist of alternatives

The most relevant coating technology with potential to replace the current use of Cr6 is presented in Table 3. The assessment of this alternative is provided in Section 3.3.

Table 3: Shortlisted alternatives.

Name	CAS or EC Number	Description of alternative
Cr3-based electroplating	CAS 10101-53-8 (Cr(III) sulphate) CAS 10025-73-7 (Cr(III) chloride)	Galvanic deposition of Cr(0) from trivalent chromium (Cr(III)) compounds.

3.3. Assessment of shortlisted alternatives

3.3.1. Alternative 1: Cr3-based electroplating

3.3.1.1. General description of Alternative 1

Cr3-based and Cr6-based electroplating processes are similar in basic principle. A nickel-coated substrate is prepared through degreasing, pickling and electro-cleaning and then immersed in a plating solution (electrolyte) containing either Cr3 or Cr6. The result of both processes is a consistent metallic chromium (Cr0) coating formed on the component being plated. In practice, moving to a Cr3-based process requires changes to the installation, additional process steps and a more complex composition of bath solutions using several process chemicals.

A Cr3-based electrolyte contains a large number of active substances as well as additives which act as stabilisers, buffers etc. All AfAs for functional chrome-plating with decorative character submitted to ECHA or HSE indicate that, in addition to whichever chromium salt the process is based on, all Cr3-based processes currently available also use boric acid (a SVHC). The choice between chloride- or sulphate-based is not clear-cut. Submitted AfAs suggest chloride-based processes are cheaper but come at the expense of worse corrosion resistance and colour stability. However, the differences between them are not significant when compared with Cr6. The hazards and risks involved in using the Cr3 alternative are described in Section 3.3.1.3. The operation of the process is described in Section 3.3.1.4.

3.3.1.2. Availability of Alternative 1

Cr3-based plating solutions are now available from a range of coatings technology suppliers. A switch to this technology would require new and additional equipment which would take time to install. It would also be expected that some time would be required to enable C&E to optimise their plating processes. It is unlikely such a technology could be installed within nine months of the publication of a negative draft opinion. It is therefore arguable whether this alternative can be considered available.

3.3.1.3. Safety considerations related to using Alternative 1

Table 4 lists hazard classification and labelling information for the key substances involved in Cr3-based processes. It can be seen that, following a Substance Evaluation, both Cr3 salts have been included in a harmonisation proposal for skin sensitisation and repeated dose toxicity (fn.5). The Substance Evaluation also indicated a need for further reprotoxicity tests, expressed concern about mutagenicity, and identified a concentration of Cr6 possibly imparted in the manufacturing process which might itself be sufficient to justify classification as a SVHC. Thus it is possible that Cr3 salts could in future be classified at SVHCs according to several criteria of REACH Article 57.

Table 4: Hazard classification and labelling for Alternative 1

Substance name	Hazard class and category codes	Hazard statement codes (labelling)	Regulatory and CLP status
Chromium hydroxide sulphate (CAS 10101-53-8) (EC 233-253-2)	Acute Tox 4	H302 (Harmful if swallowed)	4 joint notifiers. 2133 notifiers did not classify the substance. REACH registered. Not included in CLP Regulation, Annex VI. Substance evaluation concluded[5] and CLH will be initiated for skin sensitization and repeated dose toxicity. Included in C&L inventory
	Skin Corr 1	H314 (Causes severe skin burns and eye damage)	
	Skin Sens 1	H317 (May cause an allergic skin reaction)	
	Eye Dam 1	H318 (Causes serious eye damage)	
	Aquatic Chronic 2	H411 (Toxic to aquatic life with long lasting effects)	
Chromium chloride (CAS 10025-73-7) (EC 233-038-3)	Acute Tox. 4	H302 (Harmful if swallowed)	41 notifiers. 6 parties notified the substance as Acute Tox 4 (H302) only. Further 6 parties notified the substance as Acute Tox 4 (H302) and Aquatic Chronic 3 (H412). REACH registered. Not included in CLP Regulation, Annex VI. Substance evaluation concluded (fn.5) and CLH will be initiated for skin sensitization and repeated dose toxicity. Included in C&L inventory
	Skin Irrit. 2	H315 (Causes skin irritation)	
	Eye Irrit. 2	H319 (Causes serious eye irritation)	
	Acute Tox. 1	H330 (Fatal if inhaled)	
Boric acid (CAS 10043-35-3) (EC 233-139-2)	Repr. 1B	H360FD (May damage fertility. May damage the unborn child)	REACH registered. Included in CLP Regulation, Annex VI (index number 005-007-00-2). Included on the Candidate List and in 6th recommendation for inclusion in Annex XIV

Table 4 also identifies boric acid as a substance used in the Cr3-based alternative, which is a SVHC recommended for inclusion in Annex XIV. Boric acid is used in the nickel-plating step of the electroplating process for both Cr6- and C3-based processes. However, boric acid is not used in the electroplating step of the Cr6-based process, but is required for Cr3, to improve the smoothness of the plated surface, to improve colour and to prevent the development of Cr6 impurities in the bath. These findings were confirmed at a recent workshop convened by ECHA to consider the suitability of Cr3-based plating processes as a replacement for Cr6. [6] In addition, the workshop found that boric acid is extremely mobile, difficult to remove from wastewater and hence potentially problematic in terms of emissions to surface water. The concentration of boric acid present in the electrolyte is at least double the concentration in nickel baths, and levels require more frequent topping-

[5] https://www.echa.europa.eu/documents/10162/08bcc9ff-13bc-d854-31ac-ad132898500e

[6] https://echa.europa.eu/documents/10162/2156132/summary_conclusions_cr_workhop_en.pdf

up, meaning that a switch to Cr3 processes would involve a significant increase in the use of boric acid compared with existing Cr6 processes.

Because no applicant for Cr6 authorisation has already set up and is operating a Cr3 process, RAC has so far declined to provide an assessment of the risks associated with Cr3-based processes on the grounds of lack of sufficient evidence/information. SEAC has therefore assumed that Cr3-based processes are suitable substitutes for Cr6. However, as set out by the European Commission, the first criterion for judging whether an alternative is a 'suitable alternative generally available' (SAGA) is that it should be safer:

'i.e. its use should represent a lower risk to human health and/or the environment as compared to the risk of using the Annex XIV substance at stake'.[7]

This is based on the findings of the European Court on the lead pigments authorisation (T-837/16). There seems to be good evidence that Cr3-based electroplating would involve a possibly significantly increased use of boric acid, a SVHC, as well as a switch to Cr3 salts which could themselves be identified as SVHCs in future. On this basis, it seems difficult to conclude that the use of Cr3-based electroplating technology would represent a reduction in risk compared with the use of existing Cr6-based processes.

3.3.1.4. Technical feasibility of Alternative 1

As described in Section 3.1.1, clients request Cr6 for their articles because it can provide a valuable combination of technical and aesthetic properties. The technical properties relate to the durability of the surface (resistance to corrosion, chemicals and scratching/chipping) and the aesthetic properties relate to glossiness and colour consistency and stability. A technically feasible alternative should be comparable in terms of these properties. In addition, it should be capable of being used with a similar set of substrates and processing conditions (although changes to process conditions can be viewed as related to economic feasibility as much as technical feasibility).

Information from the review of previous Cr6 AfAs indicates that a Cr3-based process is compatible with the same range of substrates as currently handled by C&E. Regarding process conditions, the review suggests Cr3 processes differ from Cr6 in a number of important ways. Cr3-based electrolytes contain a higher concentration of many more chemicals, including (as seen) a SVHC. The process is extremely sensitive to impurities and even slight variations in process conditions can have a significant impact on deposition and hence the quality of the resulting surface. This in turn makes the process more difficult to control and the outputs more variable. C&E found, during testing, that it would need to install an additional nickel-plating bath to avoid transferring 'impurities' from other plating processes to the Cr3 process.

C&E also encountered a commonly-reported problem with Cr3 surfaces, which is that the surface is much more porous and hence susceptible to corrosion. This is because the deposited surface is not a consistent pure chromium layer but rather a micro-cracked alloy of chromium and iron.[8] The literature review indicates that this necessitates a passivation step which is not required with Cr6. However, even with this additional passivation, testing

[7] https://echa.europa.eu/documents/10162/13637/ec_note_suitable_alternative_in_general.pdf

[8] https://www.baua.de/EN/Service/Publications/Report/Gd101.html

reported by AfA applicants demonstrates that Cr3-plated surfaces are markedly inferior to Cr6 at withstanding abrasion, salt-spray corrosion and chemical attack.[9]

The nature of the Cr3 process also explains why the surface quality and colour is variable – because the deposited surface depends on the exact combination of substances present in the electrolyte at the time of plating. If the amount of iron varies, so does the amount deposited and hence the quality and colour of the deposited layer. Figure 5Figure 5 shows examples of Claim 2 plated using Cr6 and Cr3 technologies for consideration by a prospective client. The Cr3-plated Claim 2 is the one on the right and is a distinct grey colour compared with the deep black of the Cr6 Claim 2 on the left. This colouring was judged unacceptable by the client because it would mean that the Claim 2 would not match up with other chromed pieces on the car, both generally and those located directly next to Claim 2, where colour differences are most apparent.

[redacted]

Figure 5 Cr6 (l) and Cr3 (r) plated test pieces

On the basis of the review of previous AfAs and C&E's own experience of Cr3-based plating, (and its prospective client's reaction to it), the conclusion is that Cr3-based plating technology is not a technically feasible alternative to Cr6 at this time.

3.3.1.5. Economic feasibility of Alternative 1

In the course of its exploration of Cr3-based technologies, C&E learned that it would not be able to use its existing nickel bath (which it uses for all surfaces requiring a nickel sublayer) with a Cr3-based process because of the problem of contamination, and an additional, separate nickel bath would be required at extra cost. In addition to this, Cr6 AfAs submitted to ECHA have documented extensively how a Cr3-based process would

[9] See, e.g., https://echa.europa.eu/documents/10162/aab7b3ff-adc8-807d-daa1-f57d5279fa6b, https://echa.europa.eu/documents/10162/0ef76543-fec2-3e8d-d733-37133bce38aa, https://echa.europa.eu/documents/10162/e68d2f63-45c2-f673-e648-b17caf65a722

cost more to run than Cr6. For instance, a recent application by a German contract-plater, HDO, stated:

"[T]he Cr(III) process is significantly more costly to run than the existing Cr(VI) process. The process chemicals are more expensive, the anodes are more expensive and have a shorter lifetime, and an additional ion exchanger must be run. Higher energy costs also stem from the need for a higher bath temperature and from the lower power yield. There are also higher personnel costs, because there is a need for more continuous laboratory analysis, more maintenance work required (up to seven times that of Cr(VI)) greater time in the electroplating bath and tighter control cycles due to (e.g.) colour variation and surface defects.

"Overall, the internal charge which must be levied on projects for Cr(III)-based plating is over four times the charge levied for Cr(VI) [redacted] This only reflects the higher process costs (e.g. chemicals, energy etc); once the higher management costs (laboratory analysis, quality control, maintenance etc) and scrappage rate are included, the total charge increases 6-10 times. Finally, this translates into a total increase in the costs of an electroplating project of 10-15% (once other costs such as degreasing, copper plating, nickel plating, general plant costs, higher-level personnel, etc are accounted for)." [10]

This is one of the more detailed explanations provided in AfAs of why Cr3 plating would be more expensive than Cr6 plating, but it is not different in overall conclusion from other AfAs. Similar conclusions have been reached by, for instance, Kludi,[11] Sirio Galv,[12] SRG Global,[13] and SEA-CTAC (fn.3).

This describes the direct resource costs of switching to Cr3. However, as discussed in Section 3.1, a reduction in coating quality and performance would be likely to result in a loss of business for both companies and it is expected that these lost-profit costs would greatly exceed the direct resource costs. Claim 3 [redacted]

Based on the approach adopted by SEAC to assessing economic feasibility,[14] the conclusion of this assessment is that a Cr3-based alternative is not economically feasible for the applicant.

3.3.1.6. Suitability of Alternative 1 for the applicant and in general

A Cr3-based coating technology is available in principle, although implementation would require new equipment and some time for process optimisation. It is not clear that this could be achieved in the time between a negative draft opinion and a final decision by the

[10] https://echa.europa.eu/documents/10162/0ef76543-fec2-3e8d-d733-37133bce38aa

[11] https://echa.europa.eu/documents/10162/92f142fb-99a8-73eb-8b8a-210eef413475

[12] https://echa.europa.eu/documents/10162/62a3ea86-5c1d-27d6-1857-38b1dbed242d

[13] https://echa.europa.eu/documents/10162/aab7b3ff-adc8-807d-daa1-f57d5279fa6b

[14] https://echa.europa.eu/documents/10162/17091/seac_authorisations_economic_feasibility_evaluation_en.pdf

Secretary of State to reject this application (assumed to be around nine months), and hence in practice this alternative could be said to be unavailable for the applicant.

As stated by the European Commission (fn.7), suitability comprises three aspects:

- The alternative should be safer than the existing SVHC
- The alternative should be technically feasible
- The alternative should be economically feasible

C&E tested components plated with Cr3-based technology and found they did not meet customer requirements. In this sense, this alternative is not technically feasible for the applicant. However, there is some evidence that Cr3-based technologies are being used by suppliers of chrome-plating services for automotive, sanitary and similar applications to those served by C&E. Clients which accept Cr3-plated products appear to be prepared to accept the lower performance of the surface compared with Cr6, because they sell into lower-value markets or because they wish to manage the regulatory risk they perceive is associated with continued use of Cr6. Using the logic of the European Commission note and the European Court judgement (T-837/16), it could be argued that Cr3-based alternatives are technically feasible in general, but not for the applicant.

During its exploration, C&E learned that implementing Cr3 would require additional equipment. In addition, all Cr6 AfAs submitted to ECHA have documented extensively how a Cr3-based process would cost more to run than Cr6. From this perspective, Cr3-based technology is not economically feasible from the perspective of the applicant. However, as already noted, some companies are apparently using Cr3 in the EU, which indicates that it is economically feasible for them. Using the previous logic, it could therefore be argued that Cr3-based alternatives are economically feasible in general, but not for the applicant.

Finally, regarding safety, it is significant that the European Commission's note (fn.7) states that a suitable alternative should be safer first of all. However, it should also be noted that RAC has never assessed the relative safety of Cr3, and RAC/SEAC opinions no longer include an assessment of whether a switch to alternatives would increase safety. There is nothing preventing a company from adopting an alternative which is not safer than the existing substance, if that alternative is not (yet) subject to authorisation. SEAC have actually been encouraging the adoption of Cr3 through its conclusion that it is 'generally available' thereby requiring applicants to submit a substitution plan. Yet all information which has been submitted to RAC/SEAC on this issue indicates that it is quite possible that Cr3-based chrome plating is not safer than Cr6 and could actually increase risk.

In the absence of a demonstration that Cr3 is safer, and given that what information is available suggests it might not be, the conclusion drawn here is that Cr3 is not a suitable alternative for C&E and is not clearly a suitable alternative generally.

4. SOCIO-ECONOMIC ANALYSIS

4.1. Continued use scenario

4.1.1. Summary of substitution activities

The companies involved in this application are small companies with fewer than 50 employees between them. As a result, their ability to undertake ongoing R&D is limited.

At the same time, providing the best possible finishes and products for clients is a key part of their corporate offer, and they strive to improve techniques and adopt new methods to ensure they can continue to offer clients the best possible service. C&E has a good relationship with its suppliers of coating technology and has already examined the performance of Cr3-based technologies for black chrome plating. The results were found to be unacceptable to the prospective client, but C&E will continue to monitor developments and communicate with its suppliers about new and improved alternatives.

4.1.2. Conclusion on suitability of available alternatives in general

Based on the criteria provided by the European Commission's note (fn.7), and the discussion in Section 3.3.1.6, it is concluded that there is no suitable alternative generally available to Cr6-based chrome plating technology. As per ECHA guidance, therefore, a substitution plan is not required.

4.1.3. R&D plan

As mentioned in Section 3.2.1, C&E and WHD are small companies with fewer than 50 employees between them. As a result, their ability to undertake ongoing R&D is limited. At the same time, providing the best possible finishes and products for clients is a key part of their corporate offer. As C&E states on the front page of its website:

"Our team of in-house craftsmen combine traditional techniques with new and innovative methods to produce a range of finishes to improve the appearance and functionality of your products." (fn.1)

C&E has a good relationship with its suppliers of coating technology and has already examined the performance of Cr3-based technologies for black chrome plating. The results were found to be unacceptable to the prospective client, but C&E will continue to monitor developments and communicate with its suppliers about new and improved alternatives. Any decisions to proceed with alternatives will be made in collaboration with clients who are the ultimate arbiters of quality. Where clients use multiple suppliers, any change would also need to be coordinated across multiple companies.

4.2. Risks associated with continued use

4.2.1. Impacts on humans

The CSR undertakes a calculation of the additional number of lung cancer deaths from worker exposure, based on the dose-response relationship report provided by ECHA[15]. The share of particles that enter the gastro-intestinal tract is assumed to be zero for the worker assessment, and for 'man via environment' exposure (see below).

For the lung cancer calculation, Excess Lifetime Risk (ELR) is defined as the additional or extra risk of dying from 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. The linear exposure-risk relationship for lung cancer as estimated by ECHA (2013) is given by:

Unit occupational excess lifetime mortality risk = 4 × 10-3 per µg Cr6/m3

[15] http://echa.europa.eu/documents/10162/13579/rac_carcinogenicity_dose_response_crvi_en.pdf

For risks to workers, this excess risk estimate is measured up to the age of 89, based on assumed exposure of eight hours per day for five days per week over a working life of 40 years. No exposure threshold is observed empirically for these cancer impacts, implying that excess risks occur at any level of exposure.

According to ECHA guidance Chapter R.16: Environmental Exposure Estimation (Version 2.1 – October 2012), exposure to the environment should be assessed on two spatial scales: locally in the vicinity of point sources of releases to the environment, and regionally for a larger area which includes 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 concentrations - Predicted Environmental Concentrations (PECs) - in the environmental compartments for both local and regional scales which have been calculated in the ES.

The $PEC_{local\ air}$ is used for the estimation of excess risk to the local population (on-site workers; workers in nearby sites and retail parks, local residents and visitors to retail parks). Following ECHA (2013), risks to the local population (inhabitants) are defined in terms of lung cancer from inhalation and small intestinal cancer from oral exposure (via consumption of locally sourced foodstuffs). With regard to on-site workers, visitors and workers employed within a 1km radius of the C&E plant, only risks in terms of lung cancer from inhalation exposure were considered as it is assumed that food and drinking water of these workers is not locally sourced. However, as the area within 1km of the C&E plant is an urban area with no areas given over to allotments, the likely of local residents consuming locally grown food is considered to be negligible. Consequently, for both groups, oral intake and related risk is not considered relevant.

The ELR defined for nearby workers' inhalation exposure is the same as that presented above for workers in the C&E plant. For nearby residents, the linear exposure-risk relationship for lung cancer as estimated by ECHA (2013) is given by:

Unit excess lifetime cancer risk = 2.9 × 10-2 per µg Cr6/m3

For residents' exposure via inhalation, this risk estimate is measured up to the age of 89, and is based on a 24-hour day for 365 days per year over an exposure period of 70 years.

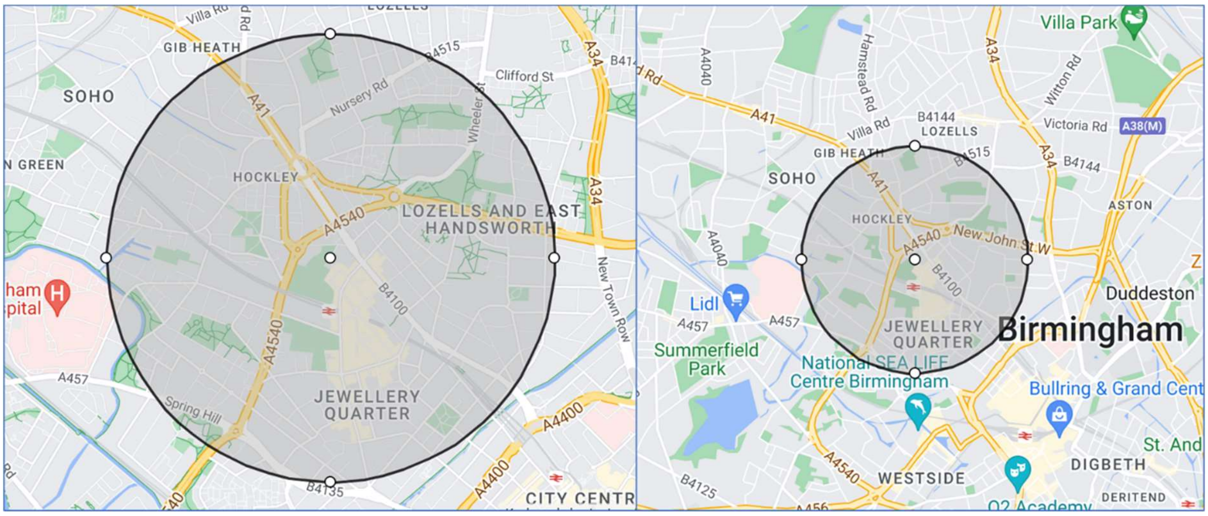

Figure 6 1km radius around the C&E plant in Birmingham

Whereas the number of workers directly exposed to Cr6 is readily calculated, the number of local residents and workers is more difficult to estimate, especially in a densely populated location such as central Birmingham. Figure 6 shows a map with a 1km radius around the C&E plant. Census estimates by postcode districts B1-4 and B16, B18 and B19 (together an area somewhat larger than a 1km radius of the C&E plant) give a local population of around 80,000, but this does not include daytime workers.[16] However, the PEC estimated in the CSR is so low (1.0 x 10-9 mg/m3) that even assuming the whole of Birmingham's population of 2m people is exposed does not generate an estimated health cost bigger than £1 per year, so this parameter is not critical to the calculation and 'man via environment' exposures can be considered negligible.

The individual development of cancer diseases may be fatal or non-fatal, whereas the exposure-response function for lung cancer is defined in terms of cancer mortality only. Therefore, the excess risk of cancer is higher than the excess risk of cancer mortality estimated via the exposure-response functions. Non-fatal cancer is most appropriately defined in terms of survival. According to Cancer Research UK, 'disease-free survival' is defined as being alive and healthy, with no recurrence, five years after initial diagnosis.[17] Accordingly, age-standardised (i.e. all-age) five-year survival statistics for lung cancer in England are provided by NHS Digital[18] and are presented in Table 5.

Table 5 Survival statistics for lung cancer in England

	Lung
Relative 5-year survival rates	21%
Non-fatal – fatal ratio	0.2662

The non-fatal – fatal ratio is calculated as follows:

Non-fatal ratio = Fatal survival rate / (1 – Fatal survival rate)

The valuation of fatal and non-fatal cases of lung cancer follows ECHA (2011) guidance on SEA. ECHA (2016)[19] has published a value for avoiding a premature death of €3.5m, with a higher value for sensitivity purposes of €5m, and for avoiding cancer morbidity (non-fatal cancer) of €0.41m (2012 prices). For this SEA, all values have been converted to sterling using the Bank of England annual average exchange rate for 2012,[20] and then inflated to 2022 using GDP deflators published by ONS.[21] The resulting values are presented in Table 6.

16 https://www.nomisweb.co.uk/sources/census_2021_pc

17 http://www.cancerresearchuk.org/about-cancer/what-is-cancer/understanding-cancer-statistics-incidence-survival-mortality#dfs

18 https://digital.nhs.uk/data-and-information/publications/statistical/cancer-survival-in-england/cancers-diagnosed-2016-to-2020-followed-up-to-2021

19 https://echa.europa.eu/documents/10162/13637/seac_reference_wtp_values_en.pdf/403429a1-b45f-4122-ba34-77b71ee9f7c9

20 https://www.bankofengland.co.uk/boeapps/database/fromshowcolumns.asp?Travel=NIxAZxSUx&FromSeries=1&ToSeries=50&DAT=RNG&FD=1&FM=Jan&FY=2010&TD=11&TM=May&TY=2025&FNY=Y&CSVF=TT&html.x=66&html.y=26&SeriesCodes=XUAAERS&UsingCodes=Y&Filter=N&title=XUAAERS&VPD=Y

21 https://www.ons.gov.uk/file?uri=/economy/grossdomesticproductgdp/datasets/uksecondestimateofgdpdatatables/quarter4octtodec2022firstestimate/firstquarterlyestimateofgdpdatatables.xlsx

Table 6: Monetary values for fatal and non-fatal cancer

	€2012	£2012	Deflator	2022
Value of cancer morbidity (non-fatal cancer)	410,000	332,334	1.25	512,569
Value of premature death	3,500,000	2,836,994		4,375,585
Value of premature death (sensitivity)	5,000,000	4,052,849		6,250,836
Value of preventing a cancer death	3,910,000	3,169,328		4,888,154
Value of preventing a cancer death (sensitivity)	5,410,000	4,385,183		6,763,405

The costs of cancer treatment are not included in the estimates but these are small in comparison with these 'human' costs, and their omission will not change the overall results significantly (if at all).[22]

4.2.2. Compilation of human health impacts

Table 7 summarises the estimation of the excess annual risk and cost of fatal and non-fatal lung cancer associated with the applicant's use of Cr6. A 10-year latency is assumed for all cancer impacts when estimating costs. The total cost of all statistical cancers associated with the applicant's use of Cr6 is £3,270 per year (£4,402 using the upper bound ECHA health impact values). (Numbers might not correspond due to rounding.)

Table 7: Cost of estimated additional statistical lung cancer cases

Population at risk	ELR	Number exposed	Statistical cases pa	Cost per case	Cost pa (£)
Fatal lung cancer, workers					
Directly exposed	1.22E-02	3	9.18E-04	4,888,154	3,181
Indirectly exposed	4.00E-12	200000	2.00E-08		0
Sub-total	1.84E-07	200003	9.18E-04		3,181
Fatal lung cancer, general population					
Local	2.90E-11	100000	4.14E-08	4,888,154	0
Regional					
Sub-total	2.90E-11	100000	4.14E-08		0
Total fatal lung cancer	1.22E-07	300003	9.18E-04	4,888,154	3,181
Non-fatal lung cancer, workers					
Directly exposed	3.25E-03	3	2.44E-04	512,569	88.67
Indirectly exposed	1.06E-12	200000	5.32E-09		0.00
Sub-total	4.88E-08	200003	2.44E-04		88.67
Non-fatal lung cancer, general population					
Local	7.71E-12	100000	1.10E-08	512,569	0
Regional					
Sub-total	7.71E-12	100000	1.10E-08		0
Total non-fatal lung cancer	3.25E-08	300003	2.44E-04	512,569	89
Total lung cancer	1.55E-07	300003	1.16E-03	2,813,898	3,270

[22] See, for example, http://www.erswhitebook.org/chapters/the-economic-burden-of-lung-disease/ , where it was estimated that, in 2011, there were 292,000 cases of lung cancer and 257,000 deaths costing €11,473 per case:

4.3. Non-use scenario

4.3.1. Summary of the consequences of non-use

If C&E was required to stop its use of Cr6, it would be expected that it would lose its Cr6-related business and WHD would lose its automotive business. This would result in a significant drop in turnover and profits, and the need for a number of redundancies. There could also be knock-on impacts on C&E's business with clients who use multiple finishes, including chrome. It is assumed that this business would be transferred to competitors of C&E and WHD, after some delay to allow for recontracting, approvals, etc.

4.3.2. Identification of plausible non-use scenarios

There are essentially three plausible non-use scenarios if C&E was required to stop its use of Cr6 (assumed to be around nine months after a negative draft opinion, or mid-2025):

1. Switch to a Cr3-based plating technology
2. Outsource Cr6-plating to another plater in GB or elsewhere (authorised if necessary)
3. Close the Cr6-plating part of the business

A fourth option, to relocate plating operations outside of GB and EU (where authorisation is not required), is not considered plausible as the companies have no experience of operating in another country, or the capability to do so.

Regarding option 1, as has already been discussed, an experimental Cr3 plating for a prospective automotive client was rejected by the client for various reasons, including colour and corrosion resistance. C&E has no reason to believe that other automotive clients and clients in other high-end sectors would not react similarly. It is possible that performance could be improved over time with some process optimisation. However, in the meantime this business would be likely to be lost, and there would be no guarantee that it would be regained even if standards could be improved. Some clients might be retained but it is not clear which. Certainly, there would be expected to be a considerable reduction in business for C&E and WHD directly related to chrome and, as explained, this could have knock-on effects on non-chrome business where clients require products in multiple finishes. This reduction in business would inevitably necessitate redundancies.

Regarding option 2, Claim 1 [redacted] It would also not be consistent with WHD's clients' general preference to reduce the number of contracts by using contractors with both design, manufacture and plating capability.

Therefore, option 3 is likely to end up being the default option anyway, as the other two options would be expected to result in Claim 1 [redacted] that WHD's automotive clients (and the vast majority of C&E's Cr6 clients) would transfer their business to other suppliers. Claim 3 [redacted]

4.3.3. Conclusion on the most likely non-use scenario

The decision to close a business is never one which is taken lightly by directors and can be expected to be a last resort. Claim 1 [redacted] the applicant considers the closure of Cr6 to be the most likely outcome in the non-use scenario, whether this is a decision which is taken proactively in the event of this AfA being rejected, or whether it simply follows on from some other course of action Claim 1 [redacted] However, it should be noted that the exact specification of the non-use scenario is less important than the identification of the expected impacts, since these could well be common across scenarios. For instance, whether Cr6 plating is closed down or contracted out makes no difference in terms of the number of redundancies which would occur at C&E. Therefore, it will be assumed that the non-use scenario will involve the closure of C&E's Cr6-plating, and the loss of WHD's automotive business. The impacts associated with this are identified in Section 4.4, and a sensitivity analysis is considered in Section 4.6.

4.4. Societal costs associated with non-use

4.4.1. Economic impacts on applicants

The non-use scenario of closing the C&E Cr6-based plating business is assumed to result in the loss of all automotive business for WHD. Automotive clients are the largest clients for Cr6-plating. Although other clients could also be lost because WHD and C&E would no longer be able to supply a full range of finishes, for simplicity only the automotive impacts are considered, so the costs of the non-use scenario are likely to be underestimated.

Over the last four years, automotive clients have accounted for Claim 3 [redacted] of WHD's total revenue of Claim 3 [redacted] per year. In turn, WHD's Cr6 business Claim 3 [redacted] represents Claim 3 [redacted] of C&E's average turnover of Claim 3 [redacted] per year. These years were significantly affected by the COVID pandemic, but are still considered reasonable estimates. The COVID pandemic also affected profitability at both companies, Claim 1 [redacted], which makes these years unreliable indicators. A reasonable measure of profitability for social cost-benefit analysis is earnings before interest and tax. Based on this measure, the average rate of return in the three years before COVID was Claim 3 [redacted], giving annual average profits from automotive of Claim 3 [redacted] Full details of these calculations are provided in the confidential spreadsheet.

The SEAC methodology for estimating losses in producer surplus relating to business closures assumes that losses occur over a period of two or four years, depending on the extent to which alternatives for a firm's outputs are available.[23] This is proposed to reflect the amount of time it takes competitors to enter the market and fill the gap in supply left by the closure. The conclusion of Section 3.3.1.6 was that there is no suitable alternative generally available for decorative-functional plating with Cr6, which following this methodology points to the use of four years. However, there are clearly other platers using Cr6 technology in GB and outside (although there might not be many of the quality provided by C&E), which would point to the use of two years. As a compromise, it will assume losses will occur over three years. Assuming losses would occur from mid-2025, with total profit loss per year of Claim 3 the estimated net present value of producer surplus losses Claim 3 of less than £2m (3.5% discount rate).

The SEAC methodology (fn.23) can be criticised because it fails to account properly for the loss in the value of capital associated with closure and the opportunity cost of capital employed to increase the supply of competitors. As a result, it almost certainly results in an underestimate of the social costs of closures.

4.4.2. Economic impacts on the supply chain

The closure of C&E's Cr6 plating business and WHD's automotive business would have impacts on their suppliers in terms of reduced sales and profits. Cost of sales are around Claim 3 of revenue for both companies. This could imply a loss of turnover for C&E's suppliers of Claim 3 per year, and of Claim 3 per year for WHD's suppliers. (See confidential spreadsheet.) Making an assumption of a 5% rate of return, this might imply loss of profits Claim 3 per year. Using the same SEAC methodology for producer surplus losses (fn.23) gives a net present value Claim 3 (less than £2m) (3.5% discount rate). There could also be some redundancies at suppliers.

WHD's automotive clients would also face some costs associated with their loss of WHD as a supplier. This is the consumer surplus associated with their demand for WHD's products, which presumably is some proportion of Claim 3 annual turnover of WHD's automotive business. As with other impacts, this cost would be temporary so long as WHD's clients were able to find satisfactory replacement suppliers at some point. Information is not available to estimate how big this cost might be.

4.4.3. Economic impacts on competitors

The approach to valuing producer surplus losses is based on the SEAC methodology (fn.23) which already accounts for gains to competitors in the non-use scenario.

4.4.4. Wider socio-economic impacts

If C&E was to close its Cr6-plating business, the reduction in turnover and profitability at both C&E and WHD would be expected to lead to a lower requirement for staff and hence the redundancy of a number of existing workers. It is estimated that Claim 3 workers in total Claim 3 would be made redundant in this scenario. The SEAC approach to estimating the societal costs of this unemployment[24] has been followed and is detailed in the confidential spreadsheet. Based on recent accounts, the average annual salary is estimated to be Claim 3 with additional costs of Claim 3. The Office for

[23] https://echa.europa.eu/documents/10162/0/afa_seac_surplus-loss_seac-52_en.pdf

[24] https://echa.europa.eu/documents/10162/17086/seac_unemployment_evaluation_en.pdf

National Statistics (ONS) does not routinely publish data on unemployment duration which is as detailed as that published by Eurostat, but Eurostat data for the UK have not been updated since the UK left the European Union. An estimate of average duration based on latest published ONS data would be just over nine months.[25] Applying the SEAC methodology to the latest available UK data published by Eurostat gives an estimate of just over 10 months, which suggests the published ONS data are reasonable.

Table 8 Societal costs of unemployment (£000)

	C&E and WHD
Lost output	Claim 4 [redacted]
Reservation wage	Claim 4 [redacted]
Search costs	Claim 4 [redacted]
Rehiring costs	Claim 4 [redacted]
Scarring	Claim 4 [redacted]
Total	Claim 4 [redacted]

Inputting these data into the SEAC methodology results in estimates of the societal costs of unemployment as shown in Table 8. Scarring and lost output are the two largest components of the total. The reservation wage component is negative and recognises the value of time during unemployment. The total cost is Claim 4 [redacted] (less than £5m) (present value, 3.5% discount rate). No other significant wider social impacts would be expected.

4.4.5. Compilation of socio-economic impacts

The socio-economic impacts of the proposed non-use scenario are presented in Table 9

Table 9: Societal costs associated with non-use.

Monetised impacts	**£**
Producer surplus loss (C&E and WHD)	Claim 3 [redacted] (less than £2m)
Social cost of unemployment	Claim 4 [redacted] (less than £5m)
Producer surplus loss (suppliers)	Claim 3 [redacted] (less than £2m)
Sum of monetised impacts	Claim 4 [redacted] (less than £9m)
Quantitatively assessed impacts	
None	
Qualitatively assessed impacts	
Consumer surplus losses for WHD clients	Temporary losses due to disruption in supply, and some permanent loss possible if replacement suppliers are inferior

4.5. Combined impact assessment

Table 10 presents the estimates of the costs of non-use alongside the health costs of continued use. The total monetised costs of non-use are Claim 4 [redacted] (less than £9m) (net

25 https://www.ons.gov.uk/employmentandlabourmarket/peoplenotinwork/unemployment/datasets/unemploymentbyageanddurationseasonallyadjustedunem01sa

present value, 3.5% discount rate). The costs of consumer surplus loss for the companies' clients are not included. The monetised costs of the health risks of continued use are £0.028m. The conclusion is that the benefits of continued use outweigh the costs [redacted] showing that authorisation of continued use is justified from a societal perspective.

Table 10: Societal costs of non-use and risks of continued use

Societal costs of non-use		Risks of continued use	
Monetised impacts	[redacted] (less than £9m)	Monetised excess risks to directly and indirectly exposed workers	£27,854
Quantitatively assessed impacts	Not applicable	Monetised excess risks to the general population	£1.26
Qualitatively assessed impacts	Consumer surplus loss of clients	Qualitatively assessed risks	Not applicable
Summary of societal costs of non-use	[redacted] (less than £9m)	**Summary of risks of continued use**	£27,855

4.6. Sensitivity analysis

The ECHA (2011) Guidance on SEA[26] proposes three levels of assessment to the approach to considering the uncertainty in the SEA:

- Qualitative assessment of uncertainties
- Deterministic assessment of uncertainties
- Probabilistic assessment of uncertainties

The ECHA guidance further states that the level of detail and resources dedicated to the assessment of uncertainties should be in fair proportion to the scope of the SEA. Further assessment of uncertainties is only needed if this is considered crucial to the overall outcome of the SEA.

The baseline results of this analysis, summarised in Table 10, are that the societal costs of non-use are [redacted] (less than £9m) and the societal costs of the risks of continued use are €0.028m. The ratio of costs to risks is high enough that there would need to be an extremely significant change in the calculations for the overall conclusion to change.

Exposure calculations made in the CSR are based on measurements, and are in line with exposures and risks reported in other Cr6 plating AfAs. Therefore, significant errors in risk estimates are unlikely, and a change in the benefit-risks comparison would need to occur in terms of a reduction in the costs of non-use, rather than an increase in health risks. This means, essentially, that the costs of non-use would need to be approximately zero for authorisation not to be justified. However, this in turn would need to mean that:

- Cr3-based plating is technically equivalent to Cr6 and no more costly

[26] https://echa.europa.eu/documents/10162/2324906/sea_authorisation_en.pdf

- Cr6 plating could be contracted out to an alternative supplier and C&E's operations transferred to that alternative supplier with no increase in cost or loss of quality
- Cr6 plating could be stopped at C&E and all workers re-employed in equally productive jobs and C&E's clients would be able to find alternative suppliers who can provide equivalent products at equal cost
- All of the above changes could happen seamlessly and immediately with no temporary negative impacts

Given the technical and economic feasibility of Cr3, and the availability of alternative suppliers, as demonstrated in this application, the conclusion is that none of the above conditions holds and hence the costs of the non-use scenario would not approach zero. Even if a suitable plating contractor could be found which would enable WHD to continue with its automotive business, and C&E's turnover (and hence profit) to be seamlessly transferred to the contractor, there would still be a need to make (at least) Claim 3 [redacted] C&E workers redundant and the costs of this alone would exceed the estimated costs of the risks of continued use by a factor of five. Therefore, the result that the benefits of authorisation exceed the risks is judged to be robust to reasonable sensitivity analysis.

4.7. Information in support of the review period

C&E and WHD are small companies with decades of expertise in high quality manufacturing and plating of diverse items for demanding applications and clients. C&E is a downstream user of Cr6-plating technologies and clearly has no capability to development alternative technologies itself, but rather is restricted to testing those which are already available on the market or which will become available in future. Thus, its ability to undertake R&D and see proactive substitution opportunities are limited. Nevertheless, it has demonstrated its willingness to consider alternatives and has undertaken a practical test of Cr3 technology to gauge client reaction.

The CSR demonstrates that the applicant's use of Cr6 and the associated exposures and risks are well-controlled. Claim 1 [redacted] and is still seeking opportunities to improve use conditions further.

If C&E was no longer allowed to use Cr6, the companies would lose their automotive business at least, leading to a significant drop in turnover and inevitable redundancies. If, as is assumed in the non-use scenario, the eventual impact of this closure would be to transfer business to other plating companies, there would be no reduction in the use of, and hence risks from, Cr6. Risks from the use of the substance could actually increase if (as is entirely possible) working practices at other companies are not as strict as those employed by the applicant.

If a suitable replacement for Cr6 was to become available, C&E could switch to it relatively quickly, albeit at some additional cost of equipment and (e.g.) inputs such as chemicals and energy. However, it is simply not known how long it might take for such a replacement to become available, particularly given that the current most likely and most developed alternative, based on Cr3, is not obviously safer than Cr6, meaning that a boric acid-free alternative is only at the earliest stage of development. This is despite Cr6 being on the Candidate List since 2010 and subject to authorisation since 2013.

Therefore, the application could be said to meet the basic RAC/SEAC criterion for a long review period – that the risks of continued use are very low, and the benefits of continued use are very high, and the situation is not expected to change in the foreseeable future.[27]

Applying for authorisation is an extremely costly undertaking for companies like C&E and WHD. Claim 1 [redacted]

The fact that the companies still want and need to apply to continue Cr6 use demonstrates the unsuitability of alternatives and how costly non-use would be. This application also demonstrates the safety and benefits of this use and hence that authorisation is clearly justified.

It is contended that there would be little value in requiring the applicant to submit a review report for this authorisation before significant progress on the development of new alternatives can be expected – this would involve high costs for the applicant, and additional workload for the HSE, whilst generating little new information and little benefit to worker or public safety. Therefore, the applicant would like to request a review period of 12 years for this authorisation.

5. CONCLUSION

- The two companies involved in this application, WH Darby Ltd and C&E Plating Ltd, are, respectively, manufacturer of badges, jewellery and other metallic objects, and provider of plating services. C&E Plating (the applicant) provides plating in a range of finishes including chrome, using technology based on chromium trioxide. This technology provides a high quality glossy and hard-wearing finish to the object plated. The products which are plated and supplied include automotive badges, civic and state regalia, electrical fittings, jewellery and clothing accessories.
- The applicant has reviewed previous applications for authorisation and consulted with its supplier regarding alternatives to chromium trioxide-based plating. It has also test-plated an object for a prospective client using a plating technology based on chromium (III) oxide. This test was rejected by the client.
- This rejection confirms the results of the application review that there is currently no suitable alternative for chrome-plating based on chromium trioxide. This is for three principal reasons – alternative technologies do not provide a finish which is as durable, resistant to corrosion and colour-stable; the alternative technologies are all significantly more expensive; the most likely alternative (based on chromium (III) oxide) is also not clearly safer than the existing technology
- Claim 1 [redacted]
- If the application is granted, the companies will continue to use chromium trioxide to provide high quality plating and plated products to clients. They are too small (fewer than 50 employees combined) to be able to undertake significant R&D into alternatives themselves, but will continue to liaise with their supplier and clients

[27] https://echa.europa.eu/documents/10162/13580/seac_rac_review_period_authorisation_en.pdf

and monitor the development of new technologies. However, as subcontractors, both companies are dependent on the preferences of their clients and exist to provide the services and products which those clients demand

- If the application is not granted, the companies expect that the chrome-plating business would be closed down and WH Darby's automotive business would be lost. This would result in a significant reduction in turnover and profits, and necessitate a number of redundancies
- The Chemical Safety Report indicates that risks to workers are well controlled, and risk to 'man via environment' are negligible. The costs of the non-use scenario are estimated to outweigh the risks of continued use by a factor of Claim 4 [redacted] This result is robust to reasonable sensitivity analysis.
- The applicant requests a review period for this authorisation of 12 years

JUSTIFICATION FOR CONFIDENTIALITY CLAIMS

Claim 1 – [redacted]

Claim 2 – [redacted]

Claim 3 – [redacted]

Claim 4 – [redacted]