ANALYSIS OF ALTERNATIVES (AoA)

and

SOCIO-ECONOMIC ANALYSIS (SEA)

including

SUBSTITUTION PLAN (SP)

Public version

Legal name of applicant: Tata Steel UK Limited

Type of application: Review report

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Prepared by: Tata Steel UK Limited
Sagentia Regulatory (Technology Sciences Group Consulting Ltd)

Substance: Chromium trioxide (EC no. 215-607-8, CAS no. 1333-82-0)

Use title: The use of chromium trioxide for the manufacture of electrolytic chromium coated steel (ECCS)

Use number: 1

Contents

Tables

Figures

Declaration

We, the Applicant (Tata Steel UK Ltd), are aware of the fact that further evidence might be requested by the Health & Safety Executive (HSE) to support the information provided in this document.

Also, we request that the information redacted from the “public version” of this combined Analysis of Alternatives, Socio-Economic Analysis and Substitution Plan is not disclosed. We hereby declare that, to the best of our knowledge as of today (23 December 2025), 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.

James Davies
Works Manager – Director
Packaging – Trostre
Llanelli, Carmarthenshire
23 December 2025

On behalf of Tata Steel UK Ltd

List of abbreviations

AfA	Application for Authorisation
AFUS	Applied-for use scenario
AoA	Analysis of Alternatives
APEAL	Association of European Producers of steel for packaging (now called Steel for Packaging Europe)
BPA	Bisphenol A
BS	British Standard (published by the British Standards Institution, BSI)
BS EN	British Standard, European Norm, i.e. a British Standard that implements a European Standard
BS EN ISO	British Standard which implements an identical European and International Standard
C&L	Classification & labelling
CAGR	Compound annual growth rate
CAS	Chemical Abstracts Service
CLP	Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures (as amended) (References in this report to CLP should be taken as referring to GB CLP, as assimilated EU law following the UK's exit from the EU and the end of the Implementation Period on 31 December 2020, unless otherwise specified.)
CMR	Carcinogenic, mutagenic or toxic to reproduction
COGS	Cost of goods sold
Cr(O)	Metallic chromium
Cr(III)	Trivalent chromium
Cr(VI)	Hexavalent chromium
CrO_3	Chromium trioxide
CSR	Chemical Safety Report
CTAC	Chromium Trioxide REACH Authorisation Consortium
D&I	Drawn and ironed (also referred to as DWI)
Defra	Department for Environment, Food & Rural Affairs
DRD	Drawn and Redrawn
DWI	Drawn and wall ironed (also referred to as D&I)
EAF	Electric Arc Furnace
EBITDA	Earnings before Interest, Taxes, Depreciation and Amortization
EC	European Commission
ECCS	Electrolytic chromium coated steel (also known as tin-free steel or TFS)
ECHA	European Chemicals Agency
ECS	Environmental contributing scenario
EEA	European Economic Area, i.e. the EU plus Norway, Iceland and Liechtenstein
ELR	Excess Lifetime Risk
EN	European Norm, i.e. European Standard (published by the European Committee for Standardisation, CEN)
EN ISO	European Standard which implements an identical International Standard

EPR	The Environmental Permitting (England and Wales) Regulations 2016
ERC	Environmental Release Category
ES	Exposure scenario
ETP	Electrolytic tin plated steel (also known as tinplate)
EU	European Union
FCM	Food contact materials
FTE	Full-time equivalent
FY	Financial Year
GB	Great Britain
HSE	Health & Safety Executive
IARC	International Agency for Research on Cancer
IPSA	Innovative Packaging Steel with Enhanced Adhesion to Organic Coatings Based on Nanostructured Interphases
ISO	International Standard (published by the International Organisation for Standardisation, ISO)
IUPAC	International Union of Pure and Applied Chemistry
LTS	Low tin steel
NPV	Net present value
NUS	Non-use scenario
OC	Operational Conditions
PC	Chemical product category
PEC	Predicted environmental concentration
PPE	Personal protective equipment
PROC	Process category
R&D	Research and development
RAC	Committee for Risk Assessment (ECHA)
RAR	Risk assessment report
RCR	Risk characterisation ratio
REACH	Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (as amended) (References in this report to REACH should be taken as referring to UK REACH, as assimilated EU law following the UK's exit from the EU and the end of the Implementation Period on 31 December 2020, unless otherwise specified.)
RMM	Risk Management Measure(s)
RPE	Respiratory protective equipment
SAGA	Suitable alternative generally available
SEA	Socio-economic analysis
SEAC	Committee for Socio-Economic Analysis (ECHA)
SEG	Similar exposure group
SR&D	Scientific research and development
SP	Substitution Plan
SU	Sector of use

SVHC	Substance of very high concern
TCCT	Trivalent Chromium Coating Technology
TFS	Tin free steel (i.e. ECCS)
TSN	Tata Steel Netherlands
TSUK	Tata Steel UK Ltd (the applicant)
TWA	Time-weighted average
VCM	Value of cancer morbidity
VSL	Value of a statistical life
WCS	Worker Contributing Scenario
WEL	Workplace exposure limit
WTP	Willingness to pay
WWTP	Wastewater treatment plant

1. Summary

Tata Steel UK Ltd ('the applicant') is the largest steel company in the United Kingdom (UK), with operations and distribution sites across the UK. It provides a vital foundation for many of the UK's key strategic supply chains, particularly in the automotive, construction, engineering and packaging sectors. It is a supplier of high-quality steel products and an innovation partner to many household names.

The applicant's site in Llanelli, Carmarthenshire (the Trostre Works) is the sole producer of electrolytic chromium coated steel (ECCS, also known as tin-free steel) and electrolytic tin plated steel (ETP, also known as tinplate) for packaging in the UK. The site, which celebrated its 70th year in 2022, manufactures up to 400,000 tonnes of tin, chromium and polymer coated steels every year for food and drinks cans, bakeware and other packaging applications. It is widely regarded as a leading supplier of high-quality packaging steels, supplying over fifty countries worldwide.

***Figure 1**: The Trostre Works in Llanelli, Carmarthenshire*

The applicant is part of Tata Steel Europe, one of the largest steel producers in Europe which manufactures and supplies high-quality strip steel products to demanding markets such as construction, automotive, packaging and engineering. Tata Steel Europe is in turn part of the Tata Steel Group which is one of the world's most geographically diversified steel producer with fully integrated operations – from mining to the manufacturing and marketing of finished products. The Tata Steel Group is itself part of the Tata Group, a global business conglomerate operating across diverse industries such as agrochemicals, automotive, chemicals, construction, finance, consumer products, and hospitality.

The applicant uses chromium trioxide at the Trostre Works for the manufacture of ECCS. The substance is used to apply a thin layer of chromium (Cr(0)) and chromium oxide onto flat metal products (steel surfaces) by electrolytic deposition. The resulting coating is free of chromium trioxide and supports excellent adhesion for a subsequent functional lacquer or laminate layer. The applicant's customers rely on this high-quality ECCS to produce food and other packaging that must meet the highest standards for safety and sustainability. A brief overview of different applications of metal packaging is given in the table below.

Application	Examples of final products
Food packaging	Vegetable and soup cans; pet food; fish cans
Beverage packaging	Beer; soft drinks
Aerosol cans	Personal care; household products
General line	Two-piece cans for paint, oil or syrups; decorative packaging (special packaging); cans for confectionery and for dry products (milk powder/coffee)
Closures and can ends	For glass bottles and glass jars; ends/rings (classic, easy open, peel off ring)
Non-packaging	Baking ware, printing plates (electronic sector)

Table 1*: Overview of the packaging applications for the applicant's products*

Figure 2*: An example of how the applicant's ECCS products (left) are used by its customers to make food packaging (centre) for well-known food brands (right)*

Chromium trioxide is listed in Annex XIV of REACH (entry no. 16) due to its classification as a carcinogen (cat. 1A) and mutagen (cat. 1B) and is subject to authorisation. The applicant already has an authorisation under REACH for the use of chromium trioxide for the manufacture of ECCS (authorisation number UKREACH/22/02/0), with a review period ending on 31 December 2027.

The applicant needs to continue to produce ECCS using chromium trioxide beyond the end of 2027. This report sets out information regarding the absence of suitable alternatives, the applicant's substitution efforts and plan, and socio-economic benefits to support an extension to the authorisation.

1.1 Analysis of alternatives (AoA)

Chromium trioxide plays a critical role in the production of the applicant's ECCS and Protact products – the structured layers of chromium metal and chromium oxide, together with the applied organic coating, provide a high and reliable standard of corrosion and chemical resistance during the lifecycle of the packaging material that cannot be achieved by other methods. In particular, for food and beverage packaging, the use of chromium trioxide:

- provides a highly chemical and corrosion-resistant surface that protects the underlying steel from reacting with the contents of the can, which could otherwise lead to contamination of the food or drink, posing health risks and compromising the integrity of the product.
- enhances the adhesion of a subsequent organic coating, which acts as a further barrier between the metal and the food. This dual-layer system ensures that the food remains uncontaminated and preserves its intended taste, texture and nutritional value over extended shelf lives.

- contributes to the mechanical strength and formability of the steel strip, which is important during the can manufacturing process to prevent defects that could compromise the seal or structure of the can and which could again result in contamination of the food or drink.

The AoA seeks to determine whether there are any suitable alternative substances or technologies to the use of chromium trioxide for the manufacture of ECCS. In particular, the AoA considers:

a) the technical feasibility of alternatives to chromium trioxide.
b) the economic feasibility of alternatives to chromium trioxide.
c) whether transferring to alternatives would result in reduced overall risks to human health and the environment.
d) whether the alternatives are available to the applicant, i.e. whether they would be of sufficient quality and accessible in sufficient quantities.

The AoA considered a comprehensive set of potential alternatives to chromium trioxide, considering information from ongoing R&D activities of the applicant, its suppliers and competitors, relevant literature and other similar applications for authorisation (AfA). The applicant's substitution efforts are currently focused on Cr(III)-based alternatives, which are considered to be the most promising, and so this was shortlisted for detailed analysis.

However, Cr(III)-based alternatives, as with all other alternatives identified, currently fail to meet necessary performance / customer acceptance criteria and thus are not technically feasible. Alternative coatings do not provide the consistently high performance of coatings deposited from chromium trioxide in terms of chemical and corrosion resistance, adhesion and food safety compliance. Potential substitutes either fall short in durability or have not met long-term food contact testing requirements. These potential substitutes therefore carry an increased risk of can failure, reduced shelf life and potential food safety issues.

A period of 15 years (from the end of the existing review period on 31 December 2027) is the minimum possible length of time within which the applicant could adequately identify a suitable replacement for chromium trioxide. In parallel, it is expected the regulatory landscape in the EU will change so that use of chromium trioxide in ECCS and other uses is permitted provided limits on environmental release and worker exposure are observed. This will have a substantial impact on the steel packaging market and future R&D commitments in the EU.

1.2 Socio-economic analysis (SEA)

For the applicant, ECCS is a strategically significant product line within its packaging steel portfolio. The company has invested heavily in the infrastructure and expertise required to produce high-quality ECCS, including advanced annealing, tempering and coating processes. These capabilities not only support domestic manufacturing, particularly in the food and beverage sector, but also position the applicant as a competitive player in the European packaging steel market. Its UK-based customers, including can-makers and food producers, rely on a stable and high-quality supply of ECCS to meet stringent food safety regulations and consumer expectations. The material's consistent mechanical properties and surface finish are essential for efficient can-making and reliable product performance.

At a national level, ECCS production supports the UK economy through employment, industrial output, supply chain stability and food security. Indeed, during the COVID-19 pandemic, the production of packaging steel for food applications was recognised as an essential activity by the UK Government, which allowed the applicant to continue producing, even during periods of strict lockdown and widespread industrial shutdowns. If the applicant were unable to supply ECCS products (including Protact products), customers would be forced to seek alternative sources, most likely from outside the UK and the EU, where the use of chromium trioxide is not as heavily regulated. This would weaken domestic manufacturing resilience and expose the food sector to supply chain vulnerabilities, including logistical challenges, increased costs and variable product quality.

The SEA evaluates potential impacts to the health of workers and the public in the vicinity of the Trostre Works that may be exposed to Cr(VI) because of ongoing electroplating activities. It also evaluates the economic and social benefits relating to these activities. The assessment focuses on impacts within the UK and the impacts are described quantitively or qualitatively, depending on the complexity of the issue and the availability of data. Impacts beyond the UK are also discussed for context where relevant.

The applicant has considered what it would do if an extension to the authorisation is not granted, i.e. the non-use scenario (NUS). Since alternative substances and technologies are not currently technically feasible, the applicant would have to cease ECCS production. ECCS products (including Protact products) are one of the two primary products made at Trostre, the other being ETP. The applicant has considered carefully whether it would be possible to continue ETP production in light of loss of ECCS and concluded this was not realistic due to the resulting loss of revenue, the inability to absorb the fixed costs of continued site operation and the high level of plant integration which would lead to regular upstream production issues and stoppages.

This means that ceasing ECCS production at Trostre would also lead to ceasing ETP production. This would result in the closure of Trostre, with major impacts for the applicant's revenue, profits and operations, particularly affecting the new electric arc furnace (EAF)-based steelmaking facility at Port Talbot. This facility, crucial for the applicant's green steel transition, would then be unable to supply [redacted] (public range: up to 500 kt/year) of hot rolled coil (HRC) to Trostre, undermining the EAF project's production assumptions and financial viability. In addition, closure of the Trostre Works would have broader implications for employment and the supply chain, including its customers, who rely heavily on its products, potentially leading to downstream business closures and relocation of domestic packaging manufacturing operations abroad.

In other words, the impacts of a refused extension to the authorisation would travel far beyond the Trostre Works. It would have significant impacts on the applicant's customers, reliant on their packaging steel products. It would also destabilise the £1.25 billion EAF business model, a strategic priority for the applicant and which is supported by a £500 million Grant Funding Agreement (GFA) with the UK Government, significantly impacting the overall competitiveness and profitability of the applicant's future operations.

On the other hand, the risks of continued use of chromium trioxide are as follows:

- health impacts on directly exposed workers at the applicant's site, conservatively monetised at £23,421 to £39,233 over the requested review period; and
- health impacts by inhalation and oral route on the local population including indirectly exposed workers, conservatively monetised at £1,264,229 to £2,163,587 over the requested review period.

The requested review period of 15 years from the end of the existing review period on 31 December 2027 is used for the purpose of the assessment. This represents the minimum possible length of time within which the applicant could adequately identify a suitable replacement for chromium trioxide and retain customer confidence as regulatory pressure to substitute chromium trioxide subsides in the EU. The SEA also considers the period between the estimated date of a refused decision, assumed for the purpose of this assessment to be 1 January 2028, i.e. the end of the current review period, and 31 December 2042, in terms of the assessment of certain economic impacts. 2025 is used as the base year for calculations.

The aggregated societal benefits of the continued use of chromium trioxide are expected to be at least [redacted] (public range: £135 million to £291 million) over the period, whereas the aggregated monetised health impacts of the use applied for are expected to be between £1.29 million to £2.20 million (lower and upper bounds over the review period of 15 years requested by the applicant). Therefore, over the 15 years, the benefits outweigh the risks by a factor of [redacted] (public range: > 60). This means that the remaining risk of continued use is 'low' and the socio-economic benefits are 'high', a situation which is unlikely to change in the next decade. This application therefore meets the criteria for a longer review period.[1]

1.3 Substitution plan (SP)

The applicant's initial AfA aimed to be a bridging authorisation, in that a promising potential alternative had been identified but more time was needed before it could be implemented. This alternative was Trivalent Chromium Coating Technology (TCCT), patented by Tata Steel and based on the use of a Cr(III) electrolyte instead of a Cr(VI) electrolyte. At the time, the applicant was covered by the AfA made by the Chromium Trioxide Authorisation Consortium (CTAC) led by Chemservice (the 'CTACSub' AfA) and did not believe the substitution plan could be completed before the anticipated end of any granted authorisation.[2] Accordingly, the applicant decided to prepare their own downstream user application, containing a substitution plan that aimed to have completed a move to the alternative during 2026.

However, since the initial AfA was made in April 2019, substitution efforts have not proceeded as originally anticipated. This is for a number of reasons, as follows:

- In October 2021, Tata Steel formally split its European operations into two separate entities: Tata Steel UK (the applicant) and Tata Steel Netherlands ('TSN'). The split resulted in the end of the operational Tata Steel Europe organisation, with the two new companies operating independently. Tata Steel Packaging's R&D facilities located at TSN (the IJmuiden Technology Centre, IJTC) continued to lead on the development of Cr(VI) alternatives, including the development of TCCT, within Tata Steel. The applicant intended to deploy the same process in the UK by purchasing the licence for the technology from TSN. To this end, the applicant had developed a capital investment proposal to replace its ECCS production at the Trostre Works with TCCT, estimated at over [redacted] (public range: > £100 million).

- However, while TCCT has allowed substitution of ECCS in some well-defined applications relevant to TSN, it has not proven to be a suitable alternative for most ECCS applications and products. Since 2019, it has been qualified for Tata Steel's 'Protact' products, a three-layer polymer-coated steel product. For other products, it is not yet technically feasible. The Cr(III)-based technology is notoriously challenging, not yet fully established at scale and resulting products do not meet the applicant's key functionality requirements nor customer acceptance requirements.

- The applicant already produces Protact products at the Trostre Works, albeit via a Cr(VI)-based process. However, the limited capacity of the Protact production line [redacted] means that Protact only accounts for around 10% of the ECCS products manufactured at Trostre. It is not economically feasible to replace existing ECCS production (based on Cr(VI) technology) with TCCT (based on Cr(III) technology) because the applicant would lose the vast majority (around 90%) of its current ECCS product range, for which TCCT is not a technically feasible alternative. Neither is it economically feasible to run ECCS and TCCT in parallel.

- The applicant remains reliant on TSN's further development of Cr(III)-based alternatives through the IJTC. However, the pace of R&D has slowed significantly. This is partly because TSN is continuing

[1] ECHA, 2024.

[2] The applicant's original AfA was submitted before the European Court of Justice (ECJ) annulled the European Commission's decision to grant authorisation for 4 of the 5 uses of chromium trioxide which had received a positive decision in the CTACSub AfA. The ECJ decision was made in April 2023 and the annulment came into effect from 20 April 2024, since when the AfA has reverted to 'decision pending' status. However, following the UK's exit from the EU and the transitional provisions for authorisation under UK REACH, the applicant is no longer covered by the CTACSub AfA which ceased to have effect under UK REACH in September 2024 (the original date of expiry of the granted authorisations).

to optimise TCCT for Protact only, since it does not manufacture other ECCS products. It is also because of the European Commission's proposal to transfer the regulation of Cr(VI) substances under EU REACH from Annex XIV (authorisation) to Annex XVII (restriction). When the restriction enters into force, the use of chromium trioxide in the EU will be able to continue without authorisation, provided the conditions of restriction are met. As a result, there will be much less emphasis on substitution in the EU.

Given these circumstances, the applicant has been forced back to a much earlier stage in their substitution efforts and with much-diminished access to the R&D capability and capacity from which they previously benefited when part of the wider Tata Steel Europe organisation.

Nevertheless, the applicant supports the objectives of authorisation under REACH and continues to look for a suitable alternative substance or technology that will facilitate an end to the use of chromium trioxide in the manufacture of ECCS. The Substitution Plan, which is integrated into this report, considers the steps proposed to switch to a Cr(VI)-free alternative in more detail, along with the associated timescales, complexities and uncertainties. As a result, **a review period of 15 years (from the end of the existing review period on 31 December 2027) is requested**.

Despite the failings of Cr(III)-based alternatives, these remain the most promising for further development and so are the applicant's focus. However, at the current stage of development, products made using Cr(III)-based alternatives have not secured acceptance by the market, with users of ECCS indicating to the applicant their intent to continue to source Cr(VI)-based ECCS manufactured in regions where the use of chromium trioxide is not subject to authorisation.

Against this background, and to assure the market of its continued ability to supply high-quality products while the search for a viable alternative continues, the applicant has developed this review report application to extend its authorisation beyond 2027.

2. Aims and scope

The applicant recognises and agrees with the objectives of REACH in seeking to substitute substances of very high concern (SVHC) with safer alternatives. This combined AoA, SEA and SP report supports the AfA, which aims to demonstrate the following:

- The applicant has a robust package of risk management measures (RMMs) in place to minimise exposure to chromium trioxide, as described in the Chemical Safety Report (CSR).
- The applicant has been conducting appropriate R&D efforts, and continues to do so, to identify suitable alternatives to the use of chromium trioxide for the manufacture of ECCS. However, there will be no suitable alternatives available to the applicant by the end of the current review period (31 December 2027).
- An AoA has been conducted for the purpose of this application to examine the technical and economic feasibility of potential alternatives, their availability and the level of risk reduction they present. The AoA has found that none of the identified potential alternatives are suitable to replace the current Cr(VI)-based technology without significant loss of technical and/or economic performance.
- A SEA has been conducted for the purposes of this application to describe and analyse the most significant relevant impacts (positive and negative effects) of granting an authorisation compared to refusing to grant the authorisation. The SEA has found that the benefits of continued use of chromium trioxide by the applicant significantly outweigh the risks of continued use for human health and the environment.
- Granting the authorisation would allow the applicant to continue to use chromium trioxide while continuing its search for a more sustainable alternative and avoiding the socio-economic impacts associated with the NUS. This would avoid the loss of a substantial value of profits and the redundancy of many hundreds of workers, amongst other very significant impacts. The applicant foresees that the substitution of chromium trioxide will not be feasible for at least the duration of the requested review period.
- The applicant has revised (and is implementing) its substitution plan which sets out, based on the current state of technology, the actions and timetable foreseen to substitute chromium trioxide with a suitable alternative. The SP describes the complexities associated with substitution and provides detail about why the review period requested is necessary.

The scope of this assessment is the evaluation of potential health impacts from exposure to chromium trioxide arising from the manufacture of ECCS at the applicant's Trostre Works site, as well as the socio-economic impacts resulting from the NUS. A detailed description of technical requirements and processes can be found in the CSR for this application.

2.1 Regulatory background for chromium trioxide

The substance subject to this AfA is chromium trioxide (EC no. 215-607-8), an inorganic, soluble salt of hexavalent chromium (Cr(VI)). Chromium trioxide was included in the candidate list of substances of very high concern (SVHC) on 15 December 2010 (ECHA Decision ED/95/2010) and was included in Annex XIV of EU REACH on 17 April 2013 (as entry no. 16) by virtue of Commission Regulation (EU) 348/2013. This was because of intrinsic properties relating to carcinogenicity and mutagenicity. It was given a latest application date of 21 March 2016 and a sunset date of 21 September 2017.

When dissolved in water, chromium trioxide forms two acids and several oligomers: chromic acid (EC no. 231-801-5), dichromic acid (EC no. 236-881-5), and oligomers of chromic acid and dichromic acid (referred as 'chromic acids and their oligomers' or as 'chromic acid'). These chemicals are all identified as SVHCs and were also included in Annex XIV of EU REACH by Commission Regulation (EU) 348/2013, as a separate entry (entry no. 17). The latest application date and sunset date are the same as those for chromium trioxide.

The applicant is a downstream user of chromium trioxide (as flakes) and of chromic acid (after dilution). As indicated in ECHA's Q&A no. 805 (dated on 04/06/2015) one application for authorisation should be made for chromium trioxide covering the further uses of the resulting chromic acids and their oligomers. This application is therefore made for chromium trioxide (entry 16 of Annex XIV of REACH) and, where needed, the assessment covers chromic acids and their oligomers in line with Q&A no. 805.

EU REACH was retained in UK law from 1 January 2021, including entries no. 16 and 17 of Annex XIV. Transitional arrangements under UK REACH are directly relevant for the applicant, as explained below.

Substance name	Intrinsic properties *	Latest application date	Sunset date
Chromium trioxide EC no. 215-607-8 CAS no. 1333-82-0	Carcinogenic (cat. 1A) Mutagenic (cat. 1B)	21 March 2016	21 September 2017
Acids generated from chromium trioxide and their oligomers EC no: Not applicable CAS no: Not applicable	Carcinogenic (cat. 1B)	21 March 2016	21 September 2017
* Intrinsic properties are those referred to in Article 57 of REACH that result in the substance being included in Annex XIV.			

***Table 2**: About chromium trioxide and its entry in Annex XIV of REACH*

The applicant already has an authorisation under REACH for the use of chromium trioxide for the manufacture of ECCS. The application was made under EU REACH and final opinions were issued on 12 June 2020 by ECHA's Risk Assessment Committee (RAC) and Committee for Socio-Economic Analysis (SEAC). However, the authorisation itself had not been granted by the European Commission by the end of the Implementation Period on 31 December 2020, following the UK's exit from the EU.

Under UK REACH transitional rules, Tata Steel resubmitted its application for authorisation as an 'in-flight' application to the Secretary of State (SoS) for the Department for Environment, Food and Rural Affairs (Defra). The authorisation was granted by the SoS on 24 January 2022 (authorisation number UKREACH/22/02/0) with a review period ending on 31 December 2027.

2.2 The applicant

2.2.1 About the applicant and its role in the UK and European steel markets

The applicant, Tata Steel UK Ltd, is a major steel manufacturer based in the UK and forms part of the wider Tata Steel Group, which is headquartered in India. The applicant operates extensively across the UK, with a significant presence in South Wales. The company is the largest steelmaker in the UK, supplying high-quality steel products such as hot-rolled, cold-rolled and coated steels to demanding markets such as construction, infrastructure, automotive, packaging and engineering.

The applicant's Port Talbot steelworks is one of the largest in Europe and serves as a central hub for the company's integrated steelmaking operations. Port Talbot is the applicant's primary steelmaking site and the molten steel produced there is cast and rolled into coils or slabs. Many of these products are transported to the applicant's other sites across the UK for further processing and value-added services, such as cold rolling, galvanising and coating. The applicant also operates facilities in Sweden, France, Germany and Norway, with sales offices across the world.

As part of its commitment to reducing environmental impacts, the applicant announced in September 2024 an investment of £1.25 billion – of which £500 million is supported by the UK Government – to transition to EAF steelmaking at its Port Talbot site. This investment is expected to enhance the UK's steel security and represents a significant step toward decarbonising the nation's steel industry. The transition is projected to reduce direct carbon emissions by 50 million tonnes over the next decade, equivalent to 1.5% of the UK's total direct CO_2 emissions alone, while maintaining an annual production capacity of three million tonnes of steel and preserving over 5,000 jobs.

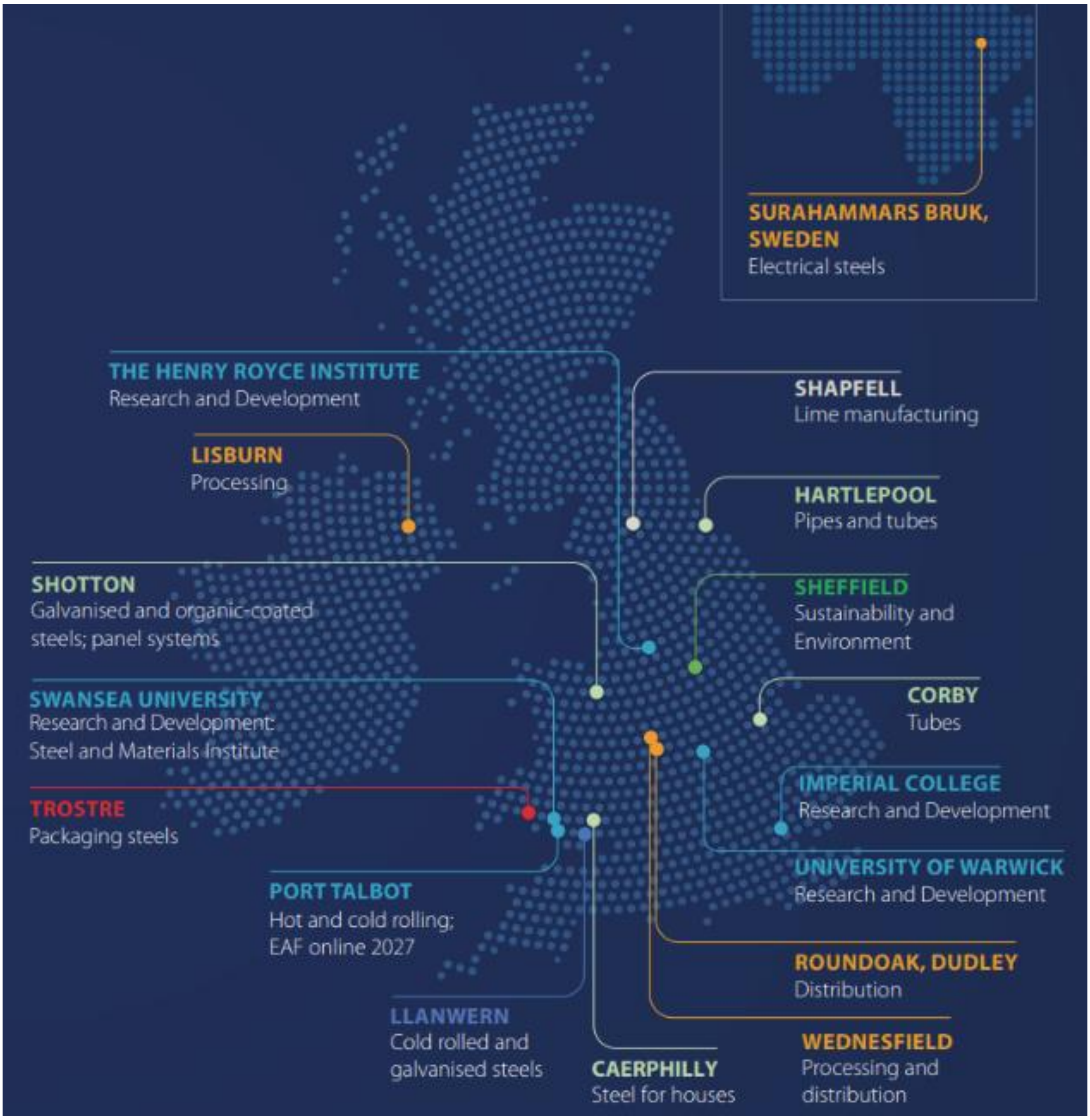

***Figure 3**: The applicant's UK sites*

These UK sites are highly integrated, i.e. they are interdependent and work together as part of a coordinated production and supply chain. This integration allows the applicant to efficiently manage the flow of materials, optimise production processes and deliver a wide range of steel products to customers. Each site has its own specialisation and strategic role in the company's steel production and processing network. The following provides an overview of the applicant's major locations and their functions:

- Port Talbot (Wales). This is the largest steelworks in the UK and one of the largest in the world. It is an integrated steelmaking facility that includes furnaces, a basic oxygen steelmaking plant and hot strip mills. Port Talbot is the heart of primary steel production in the UK and is currently undergoing a major transformation to become a hub for green steelmaking, with plans to transition to EAF technology (see below).

- Shotton Works (Deeside, Wales). Shotton is a leading site for coated steel products. It is best known for producing Colorcoat pre-finished steel, which is widely used in the construction sector for roofing and cladding.

- Llanwern (Newport, Wales). Llanwern is a key downstream processing site. It includes a hot strip mill and facilities for cold rolling and galvanizing. The site plays a crucial role in producing high-quality flat steel products for automotive and construction applications.

- Trostre (Llanelli, Wales). This site, the focus of this AfA, specialises in the production of packaging steels, primarily ETP and ECCS (including Protact). These products are used for food and beverage cans, aerosols and other packaging solutions, serving both domestic and international markets.

- Corby (England). Corby is a major hub for tubular products. It manufactures steel tubes used in construction, infrastructure and industrial applications. The site includes tube mills and finishing lines.

- Hartlepool (England). The Hartlepool site focuses on the production of large-diameter steel pipes, particularly for the energy sector, including oil and gas pipelines. It has been a key supplier for offshore and onshore pipeline projects.

- Wednesfield (Wolverhampton, England). This site is home to the Steelpark facility, one of the largest steel service centres in the UK. It provides processing and distribution services, including slitting, decoiling, and cutting to length, catering to a wide range of industries.

The interdependence between these sites means that impacts at any one site ripple across the network. For instance, the recent closure of the blast furnaces at Port Talbot meant that sites such as Llanwern, Shotton and Trostre lost their main domestic source of steel. To maintain operations, the applicant is temporarily relying on imported steel, which has introduced logistical challenges and increased costs. Similarly, were Trostre forced to close (e.g. in the event of a refused authorisation), this would mean that a significant amount of the hot rolled coil (HRC) that will be produced at the new EAF based steelmaking facility from early 2028 could no longer be supplied for further processing into packaging steels, which would fundamentally affect the production assumptions on which the EAF facility is based. This is discussed further in section 5.3 below.

The applicant's products are essential to a range of industries, including automotive, construction, engineering and packaging. Its customer base includes major companies such as BMW, Heinz, Jaguar Land Rover and JCB. The shift to EAF technology is anticipated to open new opportunities for these sectors through the supply of low CO_2 steel.

Since acquiring the UK business in 2007, the applicant has invested £4.5 billion into its UK operations, underscoring its long-term commitment to both the industry and the communities in which it operates. The additional £1.25 billion investment in the EAF project further reinforces this commitment and marks a pivotal moment in the UK's industrial strategy. It will dramatically reduce CO_2 emissions and ensure the continuation of domestic steelmaking, promoting self-sufficiency in the UK supply chain and supporting thousands of jobs and associated industries for generations to come.

2.2.2 About the Trostre Works

The Trostre Works is a prominent manufacturing site for packaging steels with a rich history. The plant was initially built by the Steel Company of Wales in 1947. The site was chosen due to its proximity to railway access and the availability of skilled labour in the region with a strong heritage in tinplate manufacture. Production at Trostre began in 1950 and, by 1956, the plant had reached its planned output of 400,000 tonnes per year. Following nationalisation of the steel industry in 1967, the site became part of the British Steel Corporation. In 1999 ownership transferred to the Corus Packaging Plus business following the merger of British Steel with Koninlijke Hoogovens. In 2007, Tata Steel completed the acquisition of Corus Group plc and has operated the facility to the present day.

***Figure 4**: The Trostre Works in Llanelli, Carmarthenshire*

At the Trostre Works, the applicant produces tin (ETP), chromium (ECCS) and polymer (Protact) coated steels, primarily for the packaging industry. The plant manufactures up to 400,000 tonnes of steel products annually, which are used by its customers to produce food and beverage cans, aerosols, paint tins and luxury packaging. The facility is equipped with advanced technology and operates under stringent health, safety and environmental standards, being subject to both the Control of Major Accident Hazards Regulations 2015 (COMAH) and the Environmental Permitting (England and Wales) Regulations 2016 (EPR). Tata Steel has continuously invested in the site, focusing on innovation, sustainability and efficiency to maintain its competitive edge in the market.

The importance and significance of the Trostre Works extends beyond its production capabilities. The facility is a major employer in the region, contributing to the local economy and providing hundreds of skilled jobs. The Trostre site also maintains close links with the local community through various bursary awards and educational awareness programmes run in local schools and colleges. Its commitment to sustainability and innovation has positioned it as a leader in packaging steels production. The plant's ability to adapt and evolve over the years has ensured its longevity and continued success, making it a vital part of Tata Steel's operations and the broader steel industry today.

2.2.3 About the applicant's use of chromium trioxide at the Trostre Works

The applicant uses chromium trioxide at the Trostre Works for the manufacture of ECCS. Chromium trioxide is used to apply a thin layer of chromium metal (Cr(0)) and chromium oxide (Cr(III)) onto flat metal products (steel surfaces) by electrolytic deposition, with the electroplating performed in a highly automated way with a minimum of exposure and emissions. The resulting coating is free of chromium trioxide and in turn provides a surface for excellent adhesion for a subsequent functional organic coating (lacquer or laminate). The applicant's products are then used by their customers to produce food packaging (cans for food and drink) and various other types of metal packaging. Further information about the electroplating process can be found in section 3.1.1 below.

2.2.4 About the applicant's products

At Trostre, the applicant produces four product types, described in further detail below:

- **ECCS**: electrolytic chromium coated steel, also known as 'tin-free steel', a process which uses chromium trioxide and which is the subject of this AfA.
- **Protact**: a type of ECCS that has been laminated with a three-layer polymer coating on each side.
- **ETP**: electrolytic tin-plated steel, also known as 'tinplate', a process which uses sodium dichromate and which is covered by a separate authorisation.
- **Blackplate**: although this usually serves as the base material for producing ECCS and ETP, it may be sold as a product in its own right.

***Figure 5**: An example of the applicant's finished products*

The Trostre Works is the only site where the applicant produces packaging steel and, more generally, Tata Steel's only European site where ECCS is produced. Trostre's customers include major global and regional brands in the food and beverage sector, as well as manufacturers of aerosols, paint cans, bottle caps, closures and high quality bakeware. These customers use the applicant's coated steel products to produce items such as food tins, beverage cans and other sealed containers that require both durability and corrosion resistance. Trostre's products are also used in non-food sectors, including personal care, household products and industrial packaging, where the steel's formability and protective coatings are essential for product integrity and shelf life. In addition, some of the ECCS produced at Trostre is further processed at Trostre to become Protact or supplied to Tata Steel's sites at Duffel (Belgium) and Ijmuiden (the Netherlands) where organic coatings are also applied on their laminating lines.

The applicant manufactures up to 400,000 tonnes of products annually. ECCS and ETP make up the vast majority of Trostre's output. The table below shows product sales and percentage splits for those products over the last five years.

[redacted]

Table 3: *Turnover and percentage split for ECCS, Protact and ETP at Trostre*

Although this AfA only covers the use of chromium trioxide for the production of ECCS, a short comparison of the different types of products manufactured by the applicant at Trostre is needed to help explain the choice customers make between different kinds of packaging materials (which is highly relevant to the AoA). The choice is not straightforward and selection depends on a number of factors which are considered further in the sections below.

2.2.4.1 ECCS (tin-free steels)

ECCS, also called tin-free steel, is an electrolytic chromium plated steel consisting of a layer of chromium metal (Cr(0)) and a layer of chromium (III) oxide (Cr_2O_3) deposited electrolytically. In the plating baths, chromium trioxide (Cr(VI)) in the electrolyte is reduced to Cr(III) and Cr(0) on the cold rolled steel base (blackplate steel). While Figure 6 below shows one layer only, the Cr(0) and Cr(III) coating gives a lustrous metallic finish on both sides of the steel plate. A layer of oil film is also applied.

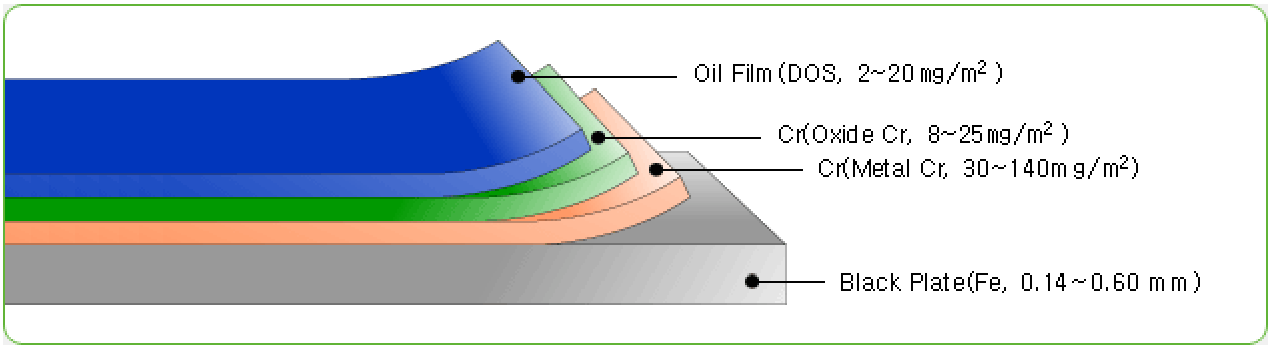

Figure 6: *Structure (layers) of ECCS*

The primary purpose of the chromium coating is to protect the blackplate from corrosion, particularly during storage before packaging is manufactured. While the chromium layer in the ECCS offers some degree of corrosion resistance, it is not sufficient on its own to withstand chemical exposure from food products. Therefore, an additional organic coating must be applied to the side of the steel strip that is in contact with the food. This coating can vary widely in composition and may include lacquers, polymer laminates, paints and other materials. Protact (discussed below) is one such example. Another important reason for applying an organic coating is to improve the workability of the steel during further processing by the applicant's customers. Since the chromium layer is very hard and brittle, it would otherwise cause excessive wear on the tools used in manufacturing. The steel surface system must support excellent adhesion to organic coatings as well as product integrity.

The chromium layer plays a crucial role in maintaining key performance characteristics of the steel, such as strong adhesion of the lacquer and resistance to corrosion. These properties are essential for protecting the material during storage and transportation, ensuring the safe preservation of food and beverages, and supporting other important functions of the packaging

2.2.4.2 Protact

Protact consists of a steel substrate coated on both sides with a three-layer polymer system, specifically engineered for use in food, aerosol, beer and beverage, and general line product applications. Each side of the ECCS substrate is coated with three distinct layers – an adhesion layer, a main functional layer, and a surface layer. Depending on the application, the coating will comprise polyethylene terephthalate (PET) or polypropylene (PP) and is available with a total coating thickness ranging from 12 to 40 µm. Each layer in the Protact polymer coating system will be independently optimised to meet customers' can performance requirements and ensure efficient processing during can making.

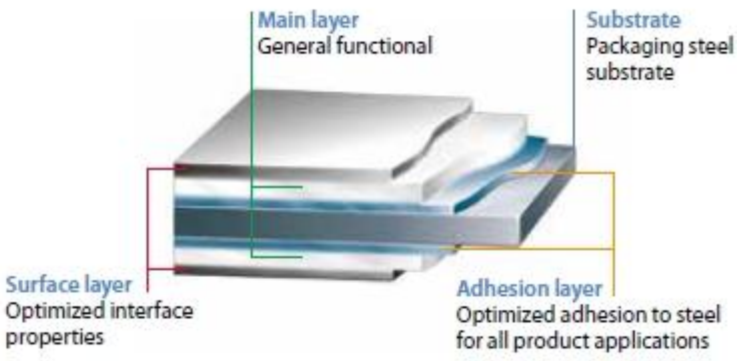

Figure 7*: Structure (layers) of Protact*

The applicant's Protact laminated steels address the growing demand for sustainable, reliable and safe packaging materials. Fully recyclable and food-safe, Protact is designed for efficient can-making and has been successfully used across a wide range of high-performance applications and formats, including drawn and redrawn (DRD) cans and drawn and wall ironed (DWI) aerosols.

Protact is also well-suited for aerosol can manufacturing, offering several advantages over traditional lacquered ends used in components such as tops and bottoms. One key benefit is the prevention of orange rust rings, which can form in humid environments like bathrooms. Traditional, more brittle lacquers are prone to corrosion when exposed to liquids such as shaving foam. In contrast, Protact's more flexible coating eliminates end corrosion by providing enhanced resistance.

A long-standing application of Protact is in the general line sector, which includes products like paint cans. In this context, Protact is used to manufacture components such as lids and rings. Its flexible coating allows for significant deformation during forming processes, while still delivering strong performance, particularly with water-based paint systems.

2.2.4.3 ETP (tinplate)

There are two types of electrolytic tinplate (ETP): passivated and non-passivated. In the case of passivated ETP, a layer of tin is first deposited onto the blackplate, followed by the application of a thin chromium oxide layer (as illustrated in Figure 8 below). The role of Cr(VI) in this process is to stabilise the surface and ensure both reliable performance and food safety. This stabilisation process is known as passivation, which refers to making the material chemically 'passive' or less reactive.

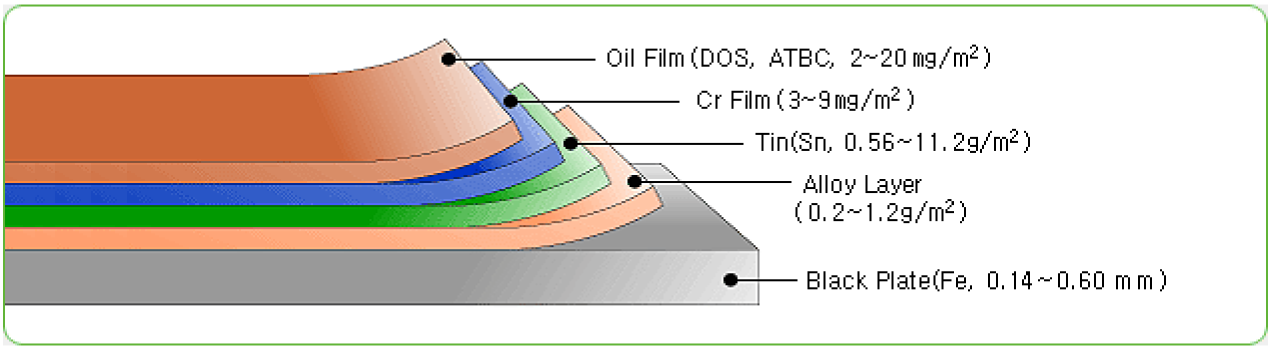

***Figure 8**: Structure (layers) of ETP*

Passivation prevents the formation of tin oxide on the surface, which would otherwise occur when tin is exposed to air. This is achieved through the electrolytic deposition of a thin chromium layer over the tin. When exposed to air, chromium naturally forms a stable layer of chromium oxide (Cr_2O_3) which, unlike iron oxide (rust), acts as a barrier, preventing oxygen from reaching the underlying metal. In addition to corrosion protection, this process also enhances the surface's adhesion properties, making it suitable for further processing and coating.

2.2.4.4 Blackplate

Blackplate is a thin, cold-rolled, low-carbon steel sheet used as the base material for ETP and ECCS. It is made by cold rolling hot-rolled coil (HRC) to achieve the desired thinness and then annealing it to restore ductility. The resulting material has a smooth, clean surface that makes it ideal for further processing. Blackplate typically ranges in thickness from about 0.14-0.49 mm, depending on the intended application.

Though not usually used directly in packaging, blackplate is essential as a substrate for coated products. When coated with a thin layer of tin, it becomes ETP (tinplate), and when electroplated with chromium, it becomes ECCS (tin-free steel). Its strength and formability influence the quality of the final coated steel. Blackplate can also be used uncoated in applications where corrosion resistance is not critical or where protective coatings are added later. Common uses include dry food containers, battery jackets, caps, stationery, decorative tins and some automotive parts. To prevent rust, it is often lacquered, painted or laminated.

2.2.5 About the use of steel for packaging applications

Packaging is one of the most ubiquitous yet under-appreciated elements of modern life. It surrounds nearly every product we encounter, from the food we eat to the tools we use, yet it rarely commands our attention. For most users, whether industrial, professional or consumer, packaging is something to be discarded, often without a second thought. However, behind every package lies a complex interplay of design, engineering, material science and regulatory compliance, all working together to ensure that products arrive safely, intact and fit for purpose.

The role of packaging extends far beyond mere containment. It is a critical component in preserving product quality, ensuring hygiene and safety, and enabling efficient transport and storage. In sectors such as food, pharmaceuticals and chemicals, packaging must meet stringent standards to prevent contamination, degradation or accidental exposure. For steel-based packaging materials like ECCS, the requirements are especially exacting, combining strength, formability, corrosion resistance and compatibility with food contact regulations.

Packaging is also increasingly at the forefront of sustainability efforts, with the demand for recyclable, reusable and resource-efficient packaging growing. Steel packaging is an important part of the solution – it is infinitely recyclable without loss of quality, and its magnetic properties make it easy to separate from waste streams. Yet even sustainable packaging must be carefully engineered to balance environmental goals with performance, cost and regulatory compliance.

Packaging manufacturers and customers have a wide array of material options available for use, with each suited to different types of products and applications. Factors that influence the selection of different packaging types include:

- *Product protection and compatibility*: The primary function of packaging is to protect the product from physical damage, contamination, moisture, light, oxygen and other environmental factors.
- *Shelf life and barrier properties*: Different materials offer varying levels of barrier protection against gases, moisture and light.
- *Sustainability*: The carbon footprint of production, ease of recycling and consumer perception of sustainability all play a role in material selection.
- *Cost and availability*: The cost of raw materials, processing and transportation significantly influences packaging choices.
- *Regulatory compliance*: Packaging materials must comply with food contact regulations, chemical safety standards and environmental regulations in the markets where the products will be sold.
- *End user convenience and functionality*: Packaging must be easy to open, reseal, store and dispose.
- *Branding and aesthetics*: Packaging is a key marketing tool. Materials are chosen not only for function but also for how they look and feel. For example, glass and metal often convey premium quality, while paper and cardboard can suggest eco-friendliness or artisanal appeal.
- *Machineability and filling requirements*: The packaging must be compatible with the producer's filling and sealing equipment.

The following sections consider why producers and suppliers will select metal packaging, particularly ECCS, from all the various options available and therefore why the continued availability and performance of such packaging remains vital.

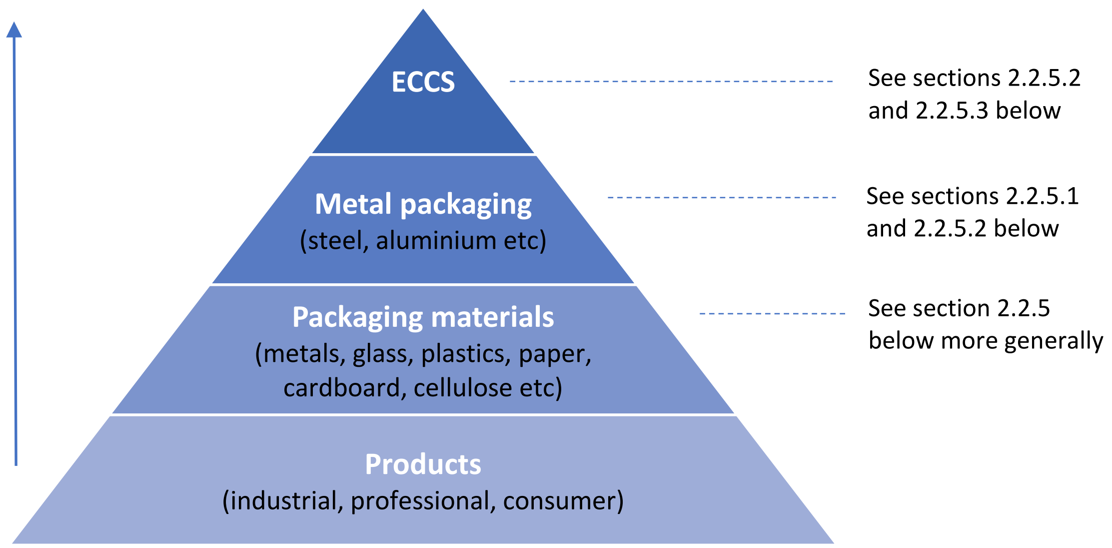

Figure 9*: Pyramid chart illustrating the selection of ECCS as a packaging material*

For food and drink packaging, the most commonly used materials include metals such as steel and aluminium, plastics, glass, cardboard and cellulose, amongst others.

- **Metals**, particularly **steel** and **aluminium**, are used extensively for beverages, soups, vegetables and pet food. Steel is often used for food cans due to its strength and excellent barrier properties, while aluminium is often used for drink cans and foil due to its lighter weight; this is further discussed below.

- **Plastics** are among the most prevalent packaging options due to their versatility, lightweight nature and cost-effectiveness. They can be moulded into various shapes and offer good barrier properties when used in multilayer formats. Common types include PET (polyethylene terephthalate), HDPE (high-density polyethylene), LDPE (low-density polyethylene), and PP (polypropylene). These are widely used for bottles, trays, films and flexible pouches. However, manufacturers and consumers are beginning to move away from plastic packaging due to increasing concerns about its environmental impacts.

- **Glass** is another traditional packaging material, valued for its inertness, transparency and premium feel. It is commonly used for drinks, sauces and preserved foods. While heavier and more fragile than other materials, glass is fully recyclable and does not interact with the contents.

- **Paper and cardboard** are widely used for dry goods, frozen foods and secondary packaging. They are biodegradable, recyclable and easy to print on, making them ideal for branding. However, they generally require coatings or laminates to provide moisture and grease resistance.

- **Biodegradable and compostable materials**, such as cellulose-based films, PLA (polylactic acid) and other bio-based plastics, are gaining popularity as sustainable alternatives. These are especially relevant in markets with strong environmental regulations or consumer demand for eco-friendly packaging.

Material	Relative cost	Recyclability	Barrier properties	Weight	Typical uses
Plastics	Low	Variable	Good	Light	Bottles, containers, trays, films, blister packs, packaging during shipping
Glass	Medium	High	Excellent	Heavy	Beverages, sauces, preserved foods, lab chemicals, cosmetics
Steel	Medium	High	Excellent	Medium	Cans for food & drink, aerosols, pet food, paint and industrial cans
Aluminium	Medium	High	Good	Light	Drink cans, foil
Cardboard	Low	High	Poor	Light	Dry goods, frozen foods, secondary packaging
Biodegradable materials	Variable	High	Variable	Variable	Various eco-friendly packaging

Table 4: *Comparison of the key properties of common packaging materials*

The selection of food and drink packaging materials is influenced by a complex interplay of factors, each tailored to the specific needs of the product, the manufacturer and the end consumer. One of the primary considerations is the nature of the contents. For food and drinks packaging, factors such as acidity, moisture content, shelf life requirements and sensitivity to light or oxygen are key. For instance, highly acidic foods may corrode certain metals, making glass or plastic more suitable. Similarly, products that require a long shelf life often benefit from materials with superior barrier properties, such as metal cans.

Cost and availability of materials also play a significant role. Plastics, for example, are often chosen for their low cost, lightweight nature and versatility in forming various shapes. Cardboard and cellulose-based materials are favoured for dry goods due to their biodegradability and ease of printing, which is advantageous for branding. Glass, while heavier and more fragile, is inert and recyclable, making it useful for premium products or those sensitive to contamination. Ceramics are less common but may be used for specialty or traditional items where aesthetics and reusability are valued.

Steel packaging, particularly in the form of ETP (tinplate) or ECCS (tin-free steel), offers numerous advantages that make it preferable in certain contexts. For instance, steel packaging used for food and drink applications offer the following benefits:

- It provides an excellent barrier against light, oxygen and contaminants, crucial for preserving the quality and safety of food over extended periods. Food and drink packed in steel cans has equivalent vitamin content to freshly prepared, without needing preserving agents.
- It is stronger than cartons or plastic, and less fragile than glass, protecting products in transit and preventing leakage or spillage, while also reducing the need for secondary packaging.
- It extends the product's shelf-life, allowing longer sell-by and use-by dates and reducing waste.
- As an ambient packaging medium, steel packaging does not require cooling in the supply chain, simplifying logistics and storage, and saving energy and costs. At the same time, steel's relatively high thermal conductivity means canned drinks chill much more rapidly and easily than those in glass or plastic bottles.
- Steel packaging without resealable closures are among the most tamper-evident of all packaging materials.
- From an ecological perspective, steel may be regarded as a closed-loop material: post-consumer waste can be collected, recycled and reused to make new cans or other products, indefinitely and without loss of quality, aligning with growing environmental concerns and regulations. Each tonne of scrap steel recycled saves 1.67 tonnes of CO_2, 1.4 tonnes of iron ore and 0.8 tonnes of coal.[3] In addition, the magnetic properties of steel also simplify the recycling process, as it can be easily separated from waste streams.

In terms of metal packaging, food and drink manufacturers also have aluminium as an alternative to steel. The choice between steel and aluminium is influenced by a combination of material properties, manufacturing requirements, product characteristics and commercial considerations. Both metals offer excellent barrier properties and recyclability but differ significantly in terms of mechanical behaviour, cost and suitability for specific applications.

Steel is typically chosen for applications that require strength, rigidity and durability. Steel is particularly well-suited to packaging formats like food cans, paint tins and aerosols where structural integrity is important. Steel's higher strength allows for thinner walls without compromising performance, which is especially valuable in pressurised containers. It also offers excellent resistance to deformation during stacking and transport. Additionally, steel's magnetic properties simplify sorting during recycling and its surface is highly receptive to coatings and lacquers, making it ideal for food contact and branding.

Aluminium, on the other hand, is lighter while still offering good levels of corrosion resistance. It is commonly used in beverage cans, foil packaging and certain types of aerosols. Its lower density makes it ideal for applications where weight reduction has a higher priority, e.g. for consumer convenience. Aluminium also has a naturally protective oxide layer, which enhances its resistance to corrosion without the need for additional coatings in some cases. Its excellent formability allows for high-speed production of thin-walled containers and it is particularly well-suited to applications requiring easy opening or resealing.

[3] See e.g. https://circulareconomy.europa.eu/platform/sites/default/files/euric_metal_recycling_factsheet.pdf

However, aluminium is generally more expensive than steel and its mechanical strength is lower, which can limit its use in larger or more demanding packaging formats. Steel, while heavier, is more robust and can be tailored through tempering and coating to meet a wide range of performance needs. For example, tinplate and tin-free steel (ECCS) offer different surface and corrosion characteristics that can be matched to the acidity of the food or the required shelf life.

As a result, manufacturers choose steel over other materials when strength, durability, coating flexibility, product integrity, long shelf life and sustainability are paramount. For example, canned vegetables, soups and carbonated beverages often use steel packaging because it ensures product safety and longevity while supporting circular economy goals. Ultimately, the decision hinges on balancing performance, cost, environmental impact, and consumer expectations.

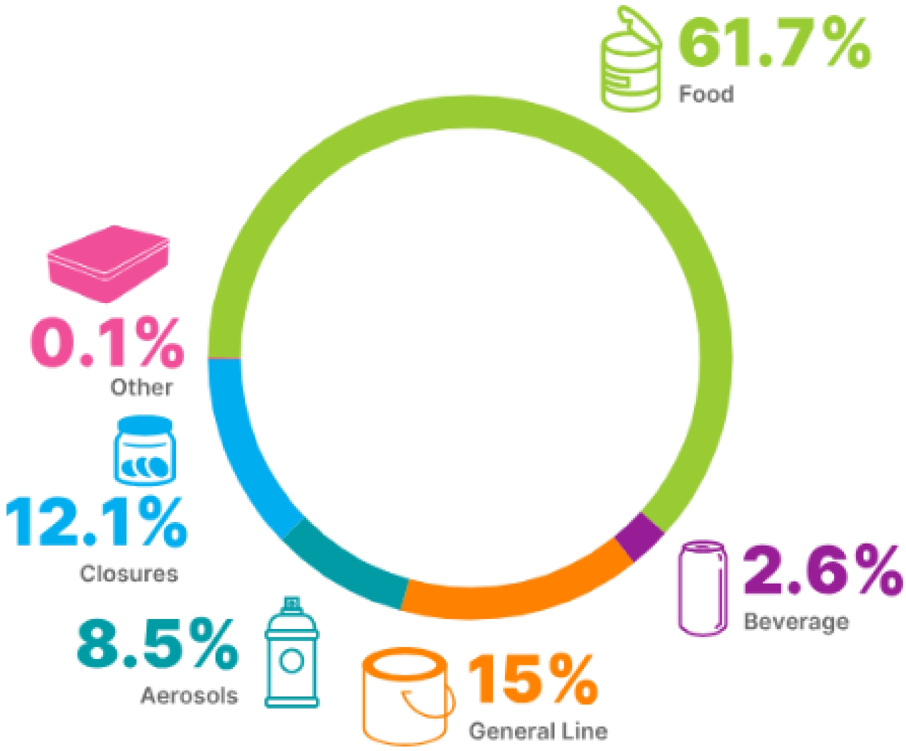

***Figure 10**: Uses of steel packaging (source: Steel for Packaging Europe)*

Steel is used extensively in packaging across a broad range of applications, including containers and closures for food and beverages (both for humans and pets) as well as for aerosols, personal care items, household and automotive products, industrial goods and paints. It is also commonly employed in giftware and promotional packaging. Additionally, steel plays a key role in hermetically sealing glass jars and bottles.

Such is its importance, during the COVID-19 pandemic the applicant's continued production of packaging steel for food applications was recognised as an essential activity in the UK. This recognition allowed the Trostre Works to keep producing, even during periods of strict lockdown and widespread industrial shutdowns. With increased consumer demand for packaged goods during the pandemic, driven by stockpiling and reduced access to fresh food, maintaining a steady supply of food-safe packaging materials became vital. The continuation of production ensured that disruptions to the food supply chain were minimised and that essential goods could continue to reach consumers safely and reliably.

2.2.5.1 Packaging applications relevant to the applicant's products

The applicant's order book covers the following packaging applications:

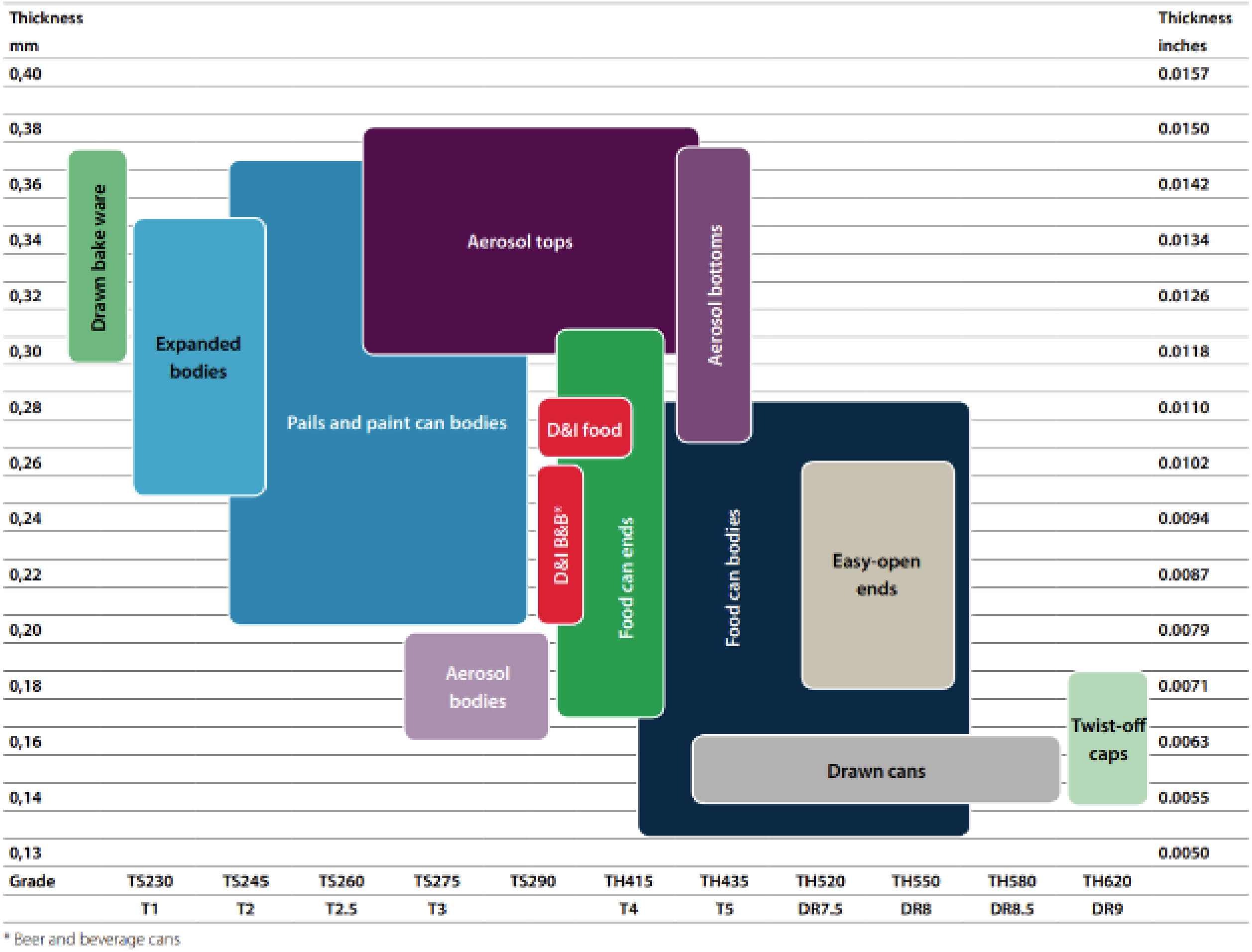

Figure 11*: The applicant's general specification window for packaging applications*

In steel packaging, the interplay between thickness and grade is crucial in determining the material's suitability for specific applications. The **thickness** of the steel affects its strength, formability and weight. Thinner steels are generally used where lightweighting is important, such as in beverage cans or aerosol containers, while thicker steels are preferred for applications requiring greater structural integrity, such as large food cans or industrial containers.

The **temper grade** of steel (often denoted by classifications like T1 or T2 etc and double-reduced grades such as DR7.5 or DR8 etc) refers to the steel's temper and mechanical properties, particularly its hardness and tensile strength. Lower temper grades like T1 and T2 are softer and more formable, making them ideal for deep-drawn applications such as two-piece food cans or complex closures. These grades allow the steel to be shaped without cracking or losing integrity. In contrast, higher temper grades like T3 or T4 are harder and stronger, suitable for flatter applications or where less deformation is required, such as in ends and lids. Double-reduced (DR) grades undergo an additional cold reduction process after annealing, which enhances their strength while maintaining a thinner gauge. This makes them particularly valuable in applications where both strength and material efficiency are critical, such as in beverage can bodies. DR grades also allow manufacturers to use less material without compromising performance, contributing to cost savings and sustainability goals.

Ultimately, the choice of thickness and grade is a balancing act between mechanical performance, formability, cost and the specific demands of the packaging application. For example, a steel grade used for a pressurised aerosol can must withstand internal pressure without deforming, while a food can might prioritise ease of sealing and corrosion resistance. The applicant's customers will select the appropriate combination based on these functional requirements, as well as regulatory standards and consumer expectations.

The applicant's customers will use their products to make metal packaging, of which there are three main types: two-piece cans, three-piece cans, and closures.

- **Two-piece cans** consist of a separate top, while the bottom and side walls are formed from a single piece of steel, as illustrated in Figure 12. The can body is created by deforming a metal disc using a high-pressure press, a process known as *drawing*. This forms the disc into a beaker-like shape. The can then undergoes a second forming stage called *redrawing*, which shapes it into its final form. These cans are commonly referred to as DRD (Drawn and Redrawn) or DWI (Drawn and Wall-Ironed, also known as D&I cans). The key difference between DRD and DWI lies in the forming process: DWI includes an additional *wall-ironing* step that stretches the metal further, resulting in taller cans. DRD cans typically start with thinner metal than DWI cans. Common examples include shallow fish cans (DRD) and beverage or beer cans (DWI). Both ECCS and ETP can be used for manufacturing these cans.

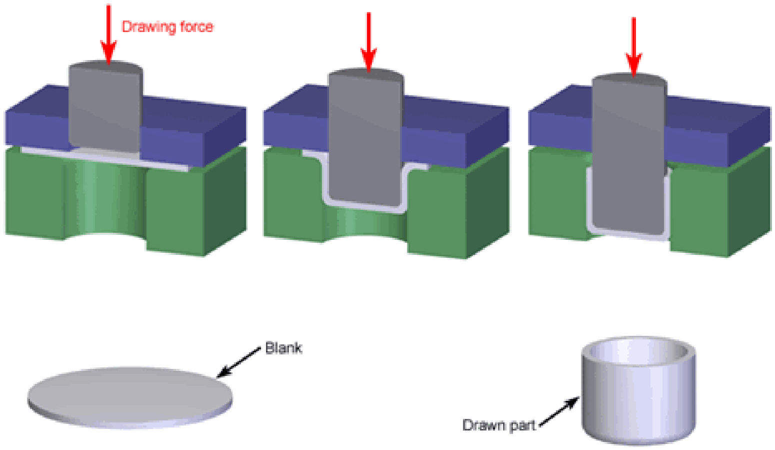

***Figure 12**: Deep drawing sequence (source: CustomPartNet)*

- **Three-piece cans** are the original form of metal cans and consist of three components: a cylindrical body, a top and a bottom. The body is formed by rolling a steel sheet into a cylinder and welding the seam. The bottom lid is then attached, and after the can is filled, the top lid is sealed on. These lids often feature circular ridges, known as expansion rings, to accommodate changes in food volume during thermal processing. The cylindrical body may also include beads to facilitate compression at the end of the can's life. Typical applications include cans for vegetables and fruits. Due to the welding process involved, only ETP steel is suitable for this type of can.

- **Closures**, also known as *ends*, *tops*, or *caps*, are used to seal containers. They can be reusable, such as jar lids or whiskey bottle caps, or single-use, like the crowns on beer bottles. Both ETP and ECCS are suitable materials for closures, depending on the specific application.

In two-piece or three-piece cans, the top lid and cylinder will be seamed together as shown in Figure 13. Extensive deformation of the steel plate is required for this process, which mechanically closes the packaging, protecting the contents from external influences like air and light. The lid itself can be of various types, such as easy opening or aluminium seal (see Figure 14 for examples).

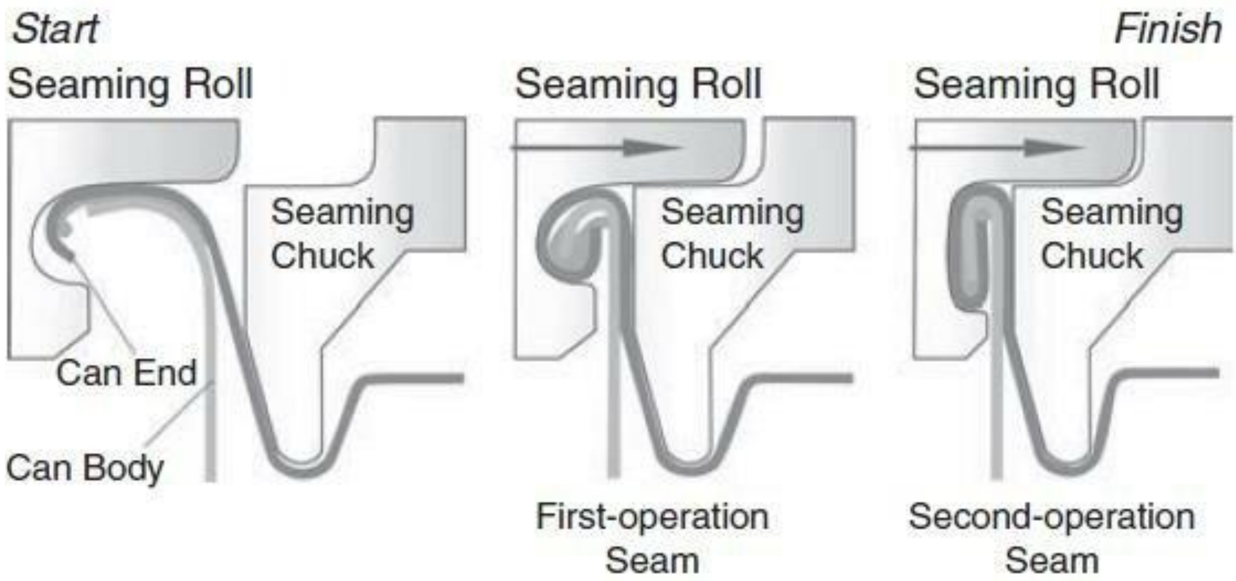

Figure 13*: A schematic of the double seam process (source: Niemiec et al.)*

If a packaging steel manufacturer like the applicant changes the specifications of its packaging steel products it can have significant implications for downstream users (customers) who convert the steel into packaging products like cans, aerosols, and containers. One of the most immediate impacts is on tooling and forming operations. Packaging manufacturers use highly specialised machinery and tooling that are finely tuned to specific material properties, including thickness, temper (hardness), surface finish and coating type. A change in any of these parameters (including changes to coatings should chromium trioxide no longer be available for use) could affect how the steel behaves during forming. For example, harder steel may crack or resist deep drawing, while thinner steel might wrinkle or fail to hold its shape. This could necessitate retooling or recalibration of equipment, which involves time, cost, and potential production downtime.

Changes in steel specification can also lead to quality and consistency issues. If the new material behaves differently under stress or during sealing, it may result in defects such as split seams, paneling (buckling) or poor lacquer adhesion. These defects not only compromise the integrity of the packaging but can also lead to product recalls or customer complaints, especially in sectors like food and pharmaceuticals where safety and shelf life are critical. Coating compatibility is another concern. Packaging steels are often coated with organic lacquers, laminates or inks for corrosion resistance and branding. A change in surface roughness or coating weight can affect how well these finishes adhere, potentially leading to flaking or corrosion over time.

From a supply chain and regulatory standpoint, any change in material specification may also require requalification or certification of the packaging, particularly for regulated markets. This can delay product launches or disrupt ongoing production schedules.

***Figure 14**: Examples of downstream uses of the applicant's ECCS products*

2.2.5.2 Factors influencing the choice of products for steel packaging applications

Just as there are choices between different types of packaging materials generally, so too are there choices between different types of packaging steels. The market for packaging steel is complex; for certain applications, different types of steel are possible while for other applications, one or the other type of packaging steel has to be used. For example, ECCS is not suitable for soldering or welding as it has a high electrical resistance, making it inferior to ETP. As a result, it is not used for the body of 3-piece cans.

In addition, the choice of organic coating can play a role in the type of steel packaging selected. This coating can be applied either before or after the metal is formed into its final shape. Where the coating is applied prior to forming, as with ECCS, it must exhibit exceptionally strong adhesion to the metal surface to withstand the subsequent mechanical forming processes. The type of organic coating itself is also influenced by the nature of the base material. For example, coatings that require high curing temperatures are unsuitable for use with ETP, due to tin's relatively low melting point, which is why the applicant's Protact product uses ECCS as its base material.

The table below provides a comparison of the properties and characteristics of ECCS and ETP which are factors in the choices made by the applicant's customers as to which type of packaging steel to purchase.

Property / characteristic	ECCS (tin-free steel)	ETP (tinplate)
Chemical composition	Low carbon steel coated with a thin layer of chromium and chromium oxide.	Low carbon steel coated with a thin layer of tin.
Surface properties	Matte, non-reflective surface. Lower brightness than ETP.	Bright, smooth, and reflective surface.
Corrosion Resistance	Excellent corrosion resistance but does need an organic coating (lacquer, laminate) to achieve this.	Excellent corrosion resistance when passivated and depending on coating weight.
Adhesion	ECCS generally offers superior coating adhesion compared to ETP. ECCS is favoured in situations where lacquer adhesion is critical, particularly for can lids and ends where the coating needs to withstand the stresses of can-making.	Relatively lower adhesion to lacquers and coatings compared to ECCS. Less suitable for the application of printing inks, enamels and varnishes than ECCS due to its tin layer which has a lower melting point.
Formability and strength	Good formability and strength, although this is dependent on an organic coating for deep drawing applications. The ECCS steel surface is very hard and causes high consumption of downstream users' processing tools in the absence of an organic coating.	Excellent formability and strength, suitable for deep drawing. However, the tin layer on the surface can generate tin dust during manufacturing due to friction between components.
Weldability	One of the most significant differences between ECCS and ETP is that ECCS is not suitable for welding or soldering.	Good weldability/solderability: this makes ETP more suitable for certain types of cans, e.g. 3 piece cans.
Food contact characteristics	ECCS is usually used for foods rich in protein or containing organic sulphur, e.g. meat, fish, peas, sweet corn. ETP is avoided because the tin in ETP steel can result in tin oxide stains.	Even when uncoated, ETP is particularly well-suited for packaging light-coloured, acidic foods. This is because tin oxidises more readily than the food itself, forming a protective layer that helps prevent discolouration and flavour changes caused by oxidation. In the case of carbonated beverages, metal packaging is predominantly made from non-passivated ETP.

Property / characteristic	ECCS (tin-free steel)	ETP (tinplate)
Organic coating	ECCS always requires at least one layer of organic coating in the final packaging.	Some passivated ETP applications, such as baby food containers, do not require an organic coating. Even if the ETP requires an organic coating, one layer is sufficient, whereas ECCS usually requires a minimum of two.
Availability	There are fewer ECCS producers than ETP producers worldwide.	There is a greater number of ETP producers, resulting in a more abundant supply compared to ECCS.
Cost	Chromium coating was primarily developed as an economic alternative to tin coating. This is due to the lower market price of chromium compared to tin, and the smaller quantity of chromium required per square metre of ECCS relative to the amount of tin used in ETP.	While ECCS may be less expensive, it always requires at least one, often two, layers of organic coating, whereas ETP may require only one layer or, in some cases, none at all. When factoring in the cost of coatings, ETP-based solutions can sometimes be more economical overall.
Sustainability	Fully recyclable, although organic coating layers may need separation. Chromium is less abundant but used in smaller quantities to make ECCS compared to tin for ETP.	Fully recyclable. However, tin has a higher environmental extraction cost and sources are slowly running out, which may change into greater demand for ECCS steel in the future.

Table 5*: Comparison of the properties / characteristics of ECCS and ETP*

2.2.5.3 Applications for which ECCS products are used

ECCS is widely used in packaging applications as a cost-effective alternative to ETP (given the substantial price difference between tin and chromium) where a combination of corrosion resistance, strength, and suitability for laminating, lacquering and printing are essential. One of its most common uses is for can ends and lids, but it also a popular choice for aerosol cans used in personal care, household and industrial products. It is also commonly used for crown caps and closures, such as those found on glass bottles for beverages like beer and soft drinks, and for general line cans as well, designed to hold products like paints, chemicals and oils. Beyond traditional packaging, ECCS may also be used for electronics and battery casings, and for decorative and promotional tins, especially for non-food items or secondary packaging.

The following tables illustrate typical packaging applications for the applicant's ECCS products.

Packaging application	Food can ends
Tata Steel grade	TS290 (T4) or TH415 (T4) Relatively high toughness
Image	**Reason**
	The heat sterilisation process preserves food naturally in a safe, strong and convenient pack without having to rely on additives and preservatives. A steel can is the only packaging that captures nutrients in heat-processed food without the need for preservatives. Packaging steel offers a 100% barrier against water, light and air and are unmatched for safety and reliability. Food cans ends made of ECCS are not susceptible to sulphur staining and blackening, which makes it the most suitable material for the market. Additionally, ECCS is cheaper than ETP, making it exceptional value.

Packaging application	Aerosols
Tata Steel grade	TH435 (T5) Excellent buckling resistance
Image	**Reason**
	Aerosols are used to dispense a wide variety of products including deodorant, shaving foam, pastes, gels, paint and edible products like cream and cheese. ECCS is ideal for aerosol cans because it combines strength and corrosion resistance, allowing it to safely contain pressurised contents which may be chemically aggressive. Its smooth surface allows for high-quality printing and decorative finishes, making it both functional and visually appealing. This balance of durability, safety and design flexibility makes ECCS a strong choice for aerosol packaging. Being made of steel, they are also fully recyclable.

Packaging application	Food can bodies
Tata Steel grade	TH415 (T4) or TH435 (T5) or TH520 (7.5) or TH550 (T8) Relatively high toughness. Excellent buckling resistance. Excellent rigidity and strength.
Image	**Reason**
	ECCS is used for food can bodies primarily because it provides a strong, lightweight steel base that can be easily formed into cylindrical shapes without cracking or losing integrity. Its thin chromium coating, when combined with an internal organic lacquer, offers excellent corrosion resistance, which is essential for preserving food safely over long periods. This protective system prevents interaction between the metal and the food, maintaining both product quality and safety. Additionally, ECCS is cost-effective and supports high-speed manufacturing processes, making it a practical choice for large-scale food can production. Food cans made of ECCS are not susceptible to sulphur staining and blackening, which makes it the most suitable material for the market. Additionally, ECCS is cheaper than ETP, making it exceptional value.

Packaging application	Drawn cans
Tata Steel grade	TH435 (T5) or TH520 (T7.5) or TH550 (T8) or TH580 (T8.5) Excellent buckling resistance. Excellent rigidity and strength
Image	**Reason**
	ECCS has excellent paint adhesion properties, far better than those of ETP, which means lacquered or laminated sheet can take considerable fabrication. The tough surface film has outstanding resistance to flaking and scratching. Also, because of its excellent non-aging properties, ECCS retains its high after-lacquering workability for long periods. These properties make ECCS the most suitable material for making many food cans. The grades used ensure the substrate can cope with the manufacturing demands and pack testing. Its compatibility with high-speed forming processes also makes it efficient for mass production.

Packaging application	Easy-open ends
Tata Steel grade	TH520 (T7.5) or TH550 (T8) Excellent rigidity and strength
Image	**Reason**
	As of 2023 in Europe, 100% of beverage cans feature easy open ends, as well as more than 90% of food cans. Can-maker developments with the ECCS substrate have made the product a leading performer. ECCS is used because it offers the right balance of strength, formability and surface quality needed for precise scoring and reliable opening performance. ECCS also allows for accurate scoring, which is critical for creating the tear line that enables the lid to open easily without compromising the can's integrity. ECCS also ensures a satisfying feel and consistent action when pulled open by consumers.

Packaging application	Drawn bakeware
Tata Steel grade	TS200 (T1) Particularly excellent flexibility
Image	**Reason**
	The material needs to be formed into various shapes and draw percentages, which requires a chemistry that can handle these varying requirements. These demands vary from baking tins to muffin trays. Due to ECCS features such as heat resistance, paint adhesion and workability after coating it is the perfect substrate in this market, where as ETP is not suitable due to the melting point of tin (232°C) and risk of oxidising/staining at elevated temperatures. ECCS' smooth, chromium-coated surface provides an excellent base for non-stick or protective coatings, which are essential for food safety and ease of cleaning.

2.3 Relevant supply chains

The supply chain for ECCS is a multi-step process with each stage involving specialised processes and stakeholders that transform the raw material into finished products suitable for packaging applications, particularly in the food and drinks industry.

The journey starts with hot rolled coil (HRC), a form of steel produced by heating steel above its recrystallisation temperature and then rolling it into a coil. Up until recently, HRC was manufactured at the applicant's Port Talbot site and supplied directly to Trostre. However, with the closure of the blast furnaces in 2024, the applicant is currently sourcing HRC from elsewhere, including Tata Steel sites in the EU as well as other suppliers in the EU and the rest of the world.

Supply of HRC from Port Talbot is planned to resume from late 2027 or early 2028 when EAF-based steelmaking operations commence. [redacted]

[redacted]

At Trostre, HRC is converted to blackplate, a thin, cold-rolled low-carbon steel sheet which serves as the base material for ECCS. The HRC is passed through a series of cold rolling mills, reducing its thickness and adjusting its surface finish. After cold rolling, the steel is brittle, so it is annealed to recover its mechanical properties. Once the blackplate is ready, it is coated with a thin layer of metallic chromium and chromium oxide on both sides using an electrolytic process. After coating, the ECCS is typically oiled to prevent oxidation and then either shipped in coils or cut into sheets. The applicant will also convert some of the ECCS to Protact on its lamination line at Trostre (or supply the ECCS to other Tata Steel sites in the Netherlands or Belgium for conversion to Protact).

The applicant's ECCS products are then delivered to can-makers or packaging manufacturers, who further process the material by cutting, forming and welding it into various packaging components such as can bodies, can ends, can lids and closures. These manufacturers will also apply organic coatings (lacquers or laminates) unless this has already been undertaken (as is the case with the applicant's Protact product). They may also print, ink and label the packaging, e.g. for branding purposes.

The finished packaging components are then sent to filling companies, which are often food or beverage producers. These companies fill the cans or containers with their products, seal them, and prepare them for distribution. From there, the packaged goods move through the logistics and retail chain, eventually reaching consumers.

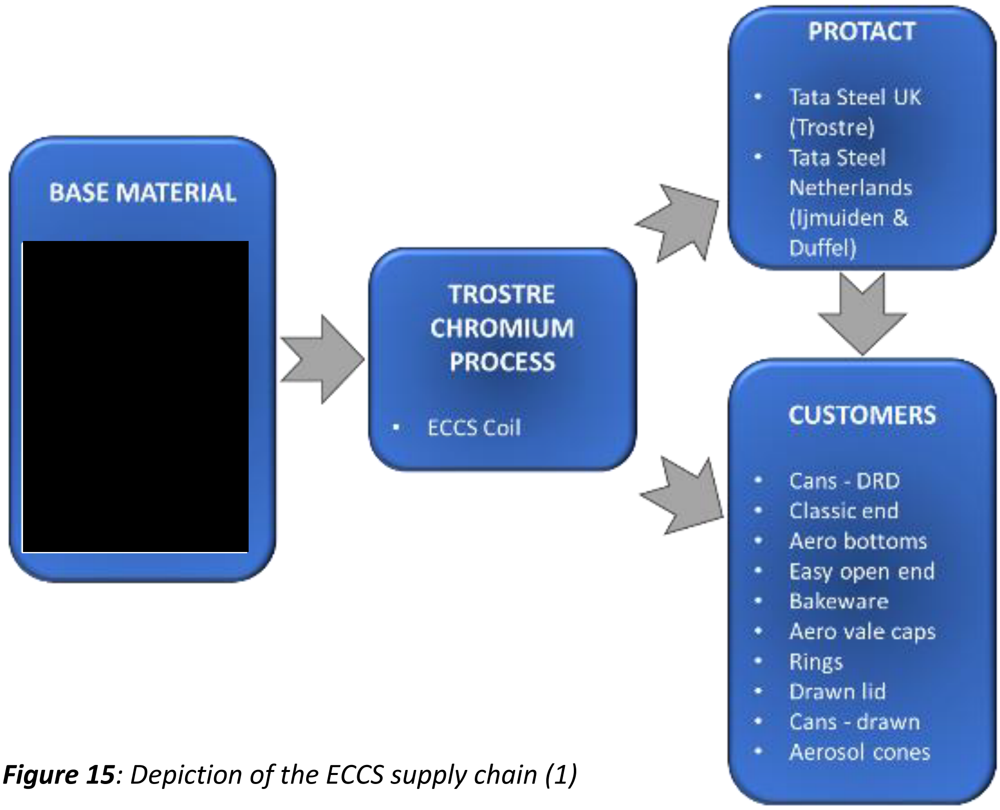

***Figure 15**: Depiction of the ECCS supply chain (1)*

The ECCS supply chain is highly interdependent, meaning that disruptions or changes in one part of the chain can significantly impact the others. This interdependence stems from the specialised nature of each step and the tight integration required to maintain quality, efficiency and regulatory compliance. For example, if there is a shortage or delay in HRC or blackplate production, it directly affects the availability of

[4] See, e.g. the applicant's 'Electrifying Packaging Steel' initiative at https://www.tatasteeluk.com/packaging/news/tata-steel-uk-launches-electrifying-packaging-steel

material for chromium coating, which in turn delays the supply of ECCS to packaging manufacturers. Since ECCS is produced to specific customer requirements (in terms of thickness, coating weight and surface finish), any upstream disruption can cause a ripple effect, leading to production halts or rescheduling downstream. Packaging manufacturers relying on just-in-time delivery may then face material shortages, delaying their ability to produce cans or other containers.

On the downstream side, changes in consumer demand or product specifications from food and beverage companies can also influence upstream supply. Each stakeholder has specific process requirements and this can significantly limit the speed at which new materials can be introduced. One of the most critical performance criteria for packaging steel is the adhesion of the organic coating (whether lacquer or laminate) to the metal substrate. For the applicant, the production of Protact laminated steel is a key differentiator and a growing market opportunity, although this is still reliant on the use of chromium trioxide. Similarly, the compatibility between lacquers and the substrate is equally important, though often more complex. This is due to the wide variety of lacquers used by different downstream processors, each with their own application methods and performance expectations.

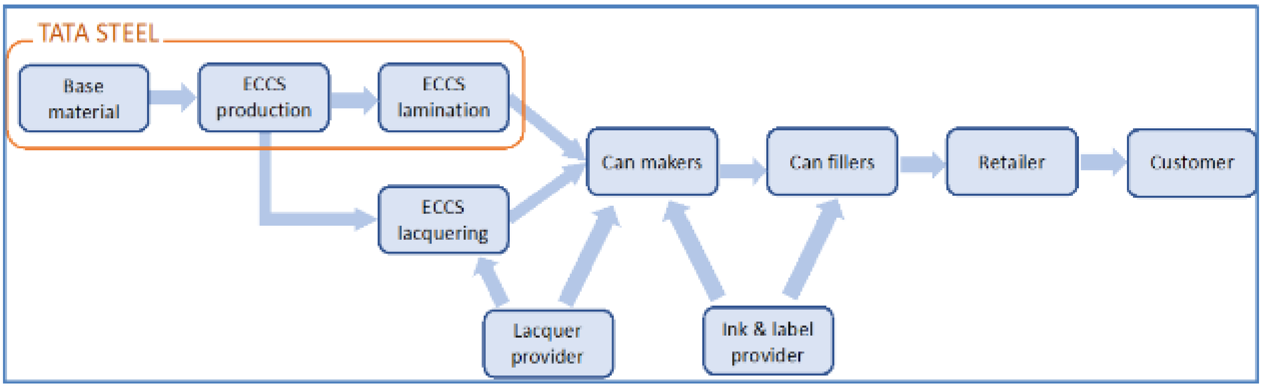

Figure 16: *Depiction of the ECCS supply chain (2)*

The supply chain is also sensitive to logistics and geopolitical factors. Trade restrictions, transportation bottlenecks or energy price fluctuations can all impact the cost and timing of materials moving through the chain. In overall terms, the ECCS supply chain is a tightly-linked system where each node relies on the timely and precise performance of the others. This makes coordination, communication and contingency planning critical for maintaining stability of production and supply, and meeting market demands.

2.4 Temporal and geographical boundaries

2.4.1 Temporal boundaries

Any calculations and considerations provided in this SEA are based on an anticipated review period of 15 years (from the end of the existing review period on 31 December 2027), which is the minimum possible length of time within which the applicant could adequately identify a suitable replacement for chromium trioxide. This review period is requested due to factors described in detail in other sections of this report, in particular, section 4 (substitution plan) and 5.7 (information to support the review period).

The SEA also considers the period between the estimated date of a refused decision, assumed for the purpose of this assessment to be 1 January 2028, i.e. the end of the current review period, and 31 December 2042, in terms of the assessment of certain economic impacts. 2025 is used as the base year for calculations, i.e. the year of submission of the review report application.

2.4.2 Geographical boundaries

The applicant's use of chromium trioxide for the production of ECCS takes place at the Trostre Works located in Llanelli, Wales. The applicant also has other manufacturing sites although does not use chromium trioxide at these sites. The UK is the geographical scope for the assessment of socio-economic impacts of not using chromium trioxide as well as the potential health impacts of the continued use. These impacts are described in section 5 of this report. Unless otherwise stated, any statistics, references and calculations used within the SEA are based on impacts associated with the UK.

2.5 Trends and impacts

2.5.1 Market analysis

2.5.1.1 Worldwide

The packaging steel market can be considered a subset of the flat steel products market. In the steel industry, 'flat products' refers to steel in sheet, plate, strip or coil form, as opposed to 'long products' like bars and rails. These flat products are commonly used in industries like automotive, aviation, construction and consumer goods. Examples of flat steel products include hot and cold rolled coil, packaging steels such as ETP and ECCS, and other products such as electrical steel and galvanised steel.

The steel value chain for flat products, such as hot-rolled coil, cold-rolled steel and coated metal products, is a complex process involving multiple stages of production, from raw material sourcing to final processing. In the steelmaking industry, higher added value comes from processing flat steel products through various additional manufacturing techniques, or through product development and related services, ultimately leading to higher profitability. The more processing steps there are, the greater the value that is created. The fewer, the less financially viable and more vulnerable the model is. Products such as slab and HRC are lower-value, commodity products whereas coated products such as hot-dip galvanised steel or ECCS, are higher-value, premium products.

For example, the figure below illustrates the value added along the value chain for flat products, beginning with key raw materials used in steelmaking. It presents recent global price trends for various stages of the production process, including iron ore, pig iron, slab, hot-rolled and cold-rolled steel coil, hot-dip galvanized sheet (HDG) and organic coated sheet (OCS). [redacted]

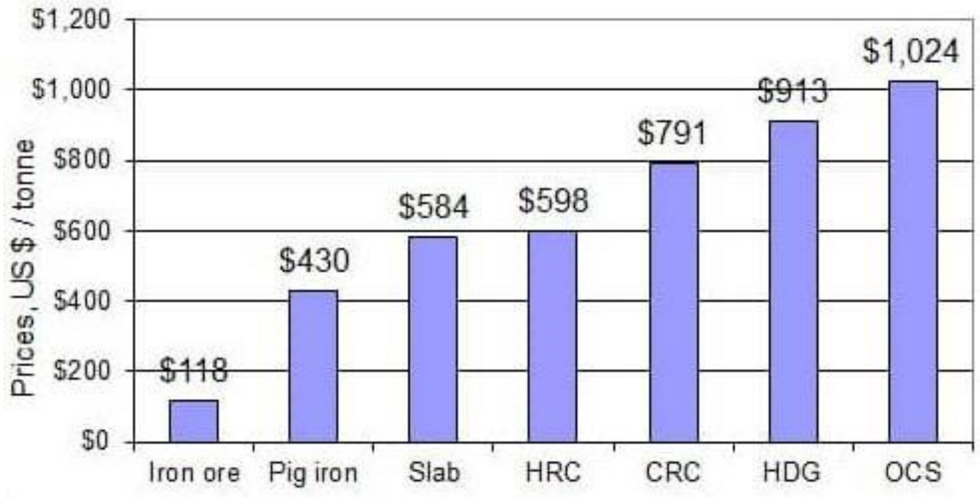

***Figure 17**: Value chain: flat steel products (as of H1 2024) (Source: Steelonthenet.com)*

Packaging steel plays a vital role in the global economy by supporting various industries, contributing to food security and facilitating the circular economy. Its durability, recyclability and ability to protect products make it a valuable component in numerous value chains, from food and beverages to chemicals and pharmaceuticals. Packaging steel primarily includes two types of steel: ETP (tinplate) and ECCS (tin-free steel) with the latter able to be further processed to make Protact products. ECCS is valued for its corrosion resistance, excellent surface finish and compatibility with lacquers and paints, making it ideal for applications like food cans, bottle caps and closures.

The packaging steel sector is sensitive to fluctuations in raw material prices, especially steel and chromium, and is also influenced by regulatory changes, including those under REACH which affects the use of substances like chromium trioxide. Additionally, shifts in consumer preferences toward sustainable and recyclable packaging materials can significantly impact demand.

In recent years, global production of packaging steels has shown a steady upward trend, driven by growing demand in both developed and emerging markets. The global packaging steel market is valued in the tens of billions of dollars, with the ECCS market alone valued at approximately $9.3 billion in 2024 and projected to grow to $13.1 billion by 2032, reflecting a compound annual growth rate (CAGR) of 4.6% during this period. This growth is underpinned by its increasing use in both the packaging and automotive sectors, reflecting the rising adoption of sustainable packaging solutions and the material's durability.

The leading producers of packaging steels are concentrated in regions with strong steel manufacturing capabilities, such as East Asia and Europe. Countries like China, Japan, South Korea, Germany, the Netherlands and the UK are prominent due to their advanced industrial infrastructure and high domestic demand. In addition to the applicant, other major companies in this space include Nippon Steel Corporation, JFE Steel and ArcelorMittal.

Demand for packaging steel is expected to grow, driven by several converging trends. These include rising urbanisation, increased consumption of packaged goods and the global shift toward recyclable and food-safe materials. However, the industry will need to continue navigating challenges such as the volatility of raw material prices and the need to comply with evolving environmental regulations. The transition away from Cr(VI) compounds is a good example of how regulatory pressures are shaping the future of the industry. Nonetheless, with ongoing innovation and adaptation, the packaging steel market is well-positioned for continued expansion.

2.5.1.2 The UK and Europe

The total European packaging steel production was estimated at 4.6 million tonnes per year in 2020, with an annual turnover of EUR 3 trillion and direct and indirect employment of over 15,000 people.[5] This represents around one-third of the estimated packaging steel production worldwide. About 25 billion food cans are produced and filled in Europe each year.

In the UK, steel is used to package more than 1,500 types of food and drink products as well as paint, health and beauty products and household products. 99.4% of UK households buy canned food each year.[6] The applicant is the most prominent player in the UK packaging steel market and the only domestic producer of ECCS. Other influential players include ArcelorMittal and JFE Steel, which supply the UK market through imports.

More generally, the UK steel sector directly employs approximately 33,700 individuals, with an additional 42,000 jobs supported across the broader supply chain.[7] Average wages in the industry are 26% higher than the national median and 35% higher than the regional median in Wales, Yorkshire, and Humberside, regions where the majority of steel sector employment is concentrated. In 2023, the UK steel industry contributed

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[5] Słowik et al., 2020.

[6] Steel for Packaging Europe (formerly known as APEAL). See https://www.steelforpackagingeurope.eu/

[7] House of Commons Library, 2025.

£1.8 billion directly to the national economy, with a further £2.4 billion generated through its supply chains. The sector also added £3.4 billion to the UK's balance of trade.[8]

Despite these contributions, recent years continue to be particularly challenging for the industry. In 2023, UK steel production and demand fell to historic lows, reaching just 5.6 million tonnes (Mt) and 7.6 Mt respectively. These levels were even lower than those recorded during the peak of the COVID-19 pandemic in 2020. At the same time, import penetration in the UK steel market continued to rise. Net imports reached 4.6 Mt in 2023, accounting for 60% of domestic demand, up from 55% the previous year. Although total import volumes declined by 5% in absolute terms, imports from countries such as India, Vietnam and France increased. These countries benefit from significantly lower electricity costs, enhancing their competitive advantage in the UK market.

The challenges faced by the UK steel sector, not least the applicant, including the following:

- **Rising energy costs**, given that steel production is highly energy-intensive. UK producers are at a disadvantage compared to regions with lower energy costs, such as the United States, Asia and certain European countries. The recent surge in electricity and gas prices has put immense pressure on profit margins, making it difficult for UK steelmakers to compete globally.

- **Environmental regulations,** which require steel manufacturers to significantly cut their carbon footprint. While these measures are crucial for sustainability, they impose substantial costs on an industry that traditionally relies on carbon-intensive processes. Transitioning to greener technologies, such as the applicant's EAF-based steelmaking at Port Talbot, requires significant investment and innovation.

- **Competition from non-UK (and often non-EU) steel producers**, particularly those in China and other Asian countries. These manufacturers benefit from lower production costs and less stringent environmental regulations, allowing them to produce steel more cheaply. The influx of low-cost steel continues to put downward pressure on prices, making it difficult for UK producers to maintain profitability, especially for lower-value, commodity products. Additionally, changing regulation of Cr(VI) substances in the EU will allow the ongoing use of Cr(VI) in the manufacture of steel packaging (both ECCS and ETP).

- **Domestic demand** for steel within the UK has been on the decline, reflecting broader economic challenges in downstream sectors such as construction and automotive. This decline in demand exacerbates the difficulties faced by the steel industry, as reduced consumption leads to lower production volumes and increased competition for limited market opportunities.

As a result, competitors will be readily able to take the applicant's market for packaging steel products if the applicant were to stop offering ECCS, e.g. as a result of a refused authorisation. In particular, because finished products ('articles' under REACH) are free from Cr(VI), ECCS manufactured outside the UK and EU, where chromium trioxide is not regulated in a similar way to REACH authorisation, can be produced without authorisation being required and imported into the UK. For example, a significant new facility for manufacturing packaging steel is currently under construction in Turkey where the Habaş Group, a major Turkish steel producer, is building a new downstream cold rolling and packaging complex in Aliağa, near Izmir, designed to meet growing demand in the metal packaging sector. This facility will feature two new ECCS production lines which are expected to use chromium trioxide for electroplating.

[8] UK Steel. See https://www.uksteel.org/steel-news-2024/key-stats-2024

2.5.1.3 The applicant's markets

The applicant is the largest supplier of ECCS (and other metal packaging products) in the UK. In 2023, the applicant's UK market share for ECCS was [redacted] (public range: >60%), compared to [redacted] imports from the EU and [redacted] imports from the rest of the world. In 2023, for all steel packaging products, i.e. ECCS, ETP and Protact combined, the applicant's market share by volume was [redacted] (public range: >75%) in the UK, [redacted] in the EU and [redacted] for the rest of the world.

The applicant is the only producer of ECCS in the UK and its ECCS line at Trostre is currently operating at full capacity. There are far fewer ECCS manufacturers than ETP manufacturers worldwide and the applicant could sell greater volumes of ECCS if they had the production capacity. Indeed, the demand for ECCS products is aptly demonstrated by the new metal packaging facility currently under construction in Turkey, as noted in the section above.

The applicant's main markets for ECCS are depicted in Figure 18 below and are predominantly for the food and drinks sector.

[redacted]

***Figure 18**: The applicant's markets for ECCS products, 2024*

The table below shows the quantity of products (in kilotonnes) invoiced by the Trostre Works in the 2024 calendar year.

[redacted]

***Table 6**: Quantity of products invoiced by the Trostre Works in 2024*

The applicant's customers include the following:

- [redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

2.5.2 Financial performance

Over the past decade, the applicant's financial performance has reflected the broader challenges and transformations within the wider steel industry, including fluctuating demand, high energy costs and increasing environmental regulations. The business has experienced periods of both profitability and significant losses, with a notable focus in recent years on restructuring and transitioning toward more sustainable steelmaking practices.

From 2014 to around 2017, Tata Steel Europe (which included UK operations at the time) faced considerable financial strain, largely due to global overcapacity in steel production, low prices and high operational costs in the UK. This led to the sale of several assets, including the long products division to Greybull Capital LLP in 2016. Between 2018 and 2020, Tata Steel Europe made some progress in stabilising its operations, but profitability remained elusive. The COVID-19 pandemic in 2020 further disrupted operations and demand, leading to additional financial pressures. Despite this, Tata Steel Europe reported a modest recovery in late 2020 and 2021, supported by a rebound in steel prices and demand.

In October 2021, Tata Steel formally split its European operations into two distinct entities: Tata Steel Netherlands (TSN) and Tata Steel UK (TSUK). This marked the end of Tata Steel Europe as a unified business, a structure that had existed since the Tata Group acquired the Anglo-Dutch steelmaker Corus in 2007. The split was a strategic move to allow each branch to operate independently under the direct oversight of the Indian parent company, Tata Steel Ltd. The restructuring, which occurred after the original AfA was submitted in 2019, aimed to allow each entity to pursue tailored strategies that aligned with their respective national regulatory environments, market conditions and sustainability goals.

The result of the split has been a clearer strategic direction for both branches. Although the separation was largely administrative, it has had substantial operational and strategic implications, allowing each entity to respond more effectively to local challenges and opportunities, as described further below. The separation has also had significant implications for the purposes of this AfA, as it resulted in the applicant losing direct access to R&D data on the further development of potential alternatives to chromium trioxide since 2021. This is considered in more detail in section 3 (analysis of alternatives) and section 4 (substitution plan) below.

In the most recent years, particularly from 2022 to 2024, the applicant has been undergoing a major transformation. The UK government and the applicant announced a £1.25 billion investment package in 2023 to support the transition from blast furnace-based steelmaking to EAF technology at the Port Talbot site. This move is aimed at reducing carbon emissions and improving long-term financial sustainability. In 2023, while revenue remained substantial, profitability was under pressure due to high energy costs and inflationary pressures. Nonetheless, the strategic shift toward greener steel production is expected to improve cost efficiency and market competitiveness in the long term.

Packaging itself currently represents around [redacted] (public range: > 15%) of the company's sales (by revenue). Packaging steel is a strategically important part of the applicant's portfolio. The business has historically emphasised its commitment to this sector due to its alignment with sustainability goals and the circular economy, given steel's high recyclability. The Trostre plant is one of the few facilities in Europe capable of producing both ETP and ECCS, making it a key asset in Tata Steel's European operations.

The table below provides information on turnover and sales price (per tonne of product) for ECCS, Protact and ETP produced at Trostre for the financial years 2021 to 2025.

[redacted]

[redacted]

***Table 7**: Turnover and sales price, 2021-2025 financial years*

The applicant does not expect sales volumes of ECCS to change significantly in the near future. The ECCS line in Trostre is currently working at capacity and therefore the sales plan is to maintain current sales volumes. [redacted]

2.5.3 Competitor information

The steel industry has historically been highly cyclical. It is significantly affected by general economic conditions, consumption trends as well as by worldwide production capacity and fluctuations in international steel trade and tariffs. This is due to the cyclical nature of the automotive, construction, machinery and equipment, packaging and transportation industries that are the principal consumers of steel.

As a result, the environment in which the applicant operates is subject to intense competition. The main challenges that the applicant faces include volatility, shifting demand centres, complex supply chains, productivity and cost efficiency. The applicant's market is also affected by general economic conditions and end-use markets, including the automotive, appliance, construction and energy industries. If these industries experience a downturn, the steel market usually follows their trend.

Packaging is a key market for the applicant and its customers are heavily reliant on its products and services. It is also strategically important for the applicant to ensure diversity of its markets (such as construction, automotive, packaging and engineering) to protect it against fluctuations in those markets. For instance, when the construction or automotive sectors are down, the packaging sector will typically be up. The applicant's ECCS process is unique and sales of packaging products are important to the resilience and flexibility of their business model.

The applicant is the only manufacturer of ECCS in the UK and holds the majority of UK market share. For instance, in 2023, the applicant's UK market share for ECCS was [redacted], with the remainder of ECCS being imported from the EU [redacted] and the rest of the world [redacted]. The applicant's main competitors in the packaging steel space are therefore non-UK manufacturers whose products are shipped to the UK. They include:

- In the EU, ArcelorMittal in Spain and France [redacted] Thyssenkrupp Rasselstein in Germany [redacted] and Acciaierie d'Italia in Italy [redacted]
- In the Middle East / North Africa, Erdermir in Turkey [redacted] and Habas in Turkey [redacted] currently under construction)
- In North America, ArcelorMittal, US Steel and POSCO [redacted] and Cleveland Cliffs [redacted]
- In Latin America / Caribbean, Companhia Siderúrgica Nacional (CSN) in Brazil [redacted]
- In Asia, Dongbu Steel and TCC Steel in South Korea, Nippon Steel and JFE Steel in Japan, Ton Yi and Kao Hsing Chang in Taiwan, Tata Steel in India and Thai Tinplate in Thailand [redacted]

In relation to EU-based competitors, chromium trioxide is also subject to authorisation under EU REACH, although EU-producers of ECCS using Cr(VI) processes already have authorisations or are covered by an upstream authorisation, as shown in the table below.

AfA ID	Applicant name	Quantity (tonnes per year)	Application type	Review period requested	Review period granted
0032-02	Chemservice et al * (CTACSub, use 5)	< 900	Upstream	12 years	7 years (until 21 September 2024)
0134-02	ThyssenKrupp Rasselstein GmbH	200	Downstream	10 years	10 years (until 31 December 2028)
0146-01	Tata Steel UK Ltd **	71	Downstream	8 years	8 years (until 31 December 2027)
0274-03	ArcelorMittal France; ArcelorMittal Spain	< 100	Downstream	7 years	7 years (until 31 December 2028)
0297-01	Acciaierie d'Italia S.p.A.	< 150	Downstream	7 years	7 years (until 31 December 2028)
0364-012	Chemservice et al (CTACSub2, use 12)	135	Upstream	7 years	-

Notes:

* The application for authorisation for this use was granted in December 2020 but annulled by the European Court of Justice (ECJ) in April 2023, which came into effect in April 2024. The application then went back to 'decision pending' status and the Commission must now prepare a new decision on this annulled use.

** The authorisation had not been granted by the European Commission by the end of the Implementation Period on 31 December 2020, following the UK's exit from the EU. Under UK REACH transitional rules, Tata Steel resubmitted its application for authorisation as an 'in-flight' application to the SoS for Defra, which was granted on 24 January 2022 (authorisation number UKREACH/22/02/0) with a review period ending on 31 December 2027

Table 8*: Applications for authorisation under EU REACH relevant to the use of chromium trioxide for the production of ECCS*

There are three EU-based members of Steel for Packaging Europe (formerly known as APEAL) that manufacture ECCS material within Europe. These three companies, Acciaierie d'Italia, ArcelorMittal and Thyssenkrupp Rasselstein, likely represent the total production of ECCS in Europe. As can be seen in the table above, all are covered by authorisations.

The review periods of the authorisations granted to the applicant's EU-based competitors expire on 31 December 2028. However, by this stage it is anticipated that their use of chromium trioxide can continue without further authorisation (by way of review report submission) due to the proposed restriction of Cr(VI) substances under EU REACH. This will see chromium trioxide, as well as other related substances, move from Annex XIV (authorisation) to Annex XVII (restriction) of EU REACH. The current restriction proposal would allow for the continued use of chromium trioxide for the production of ECCS provided that specified worker and environmental exposure limits are not exceeded.

For the applicant's non-EU competitors, chromium trioxide is not regulated in the way it is under REACH (nor is it currently subject to restriction proposals) meaning they do not face similar regulatory challenges.

Finished products that have been electroplated using chromium trioxide (such as ECCS) no longer contain any Cr(VI) and do not present a risk to human health or the environment. There are no regulatory barriers to the export of chromium-plated goods from non-UK countries to the UK, given that REACH authorisation requirements do not apply to imported articles.

Taking all the above into account, this means that there is, and will continue to be, a large source of Cr(VI)-based ECCS manufactured outside the UK which is readily available for import into the UK. Consequently, if the applicant attempts to move away from ECCS manufactured using chromium trioxide to products made using inferior alternatives, it will be hampered by the continued availability of Cr(VI)-based ECCS from abroad. If the applicant were no longer able to offer Cr(VI)-based ECCS, its customers would all have the option of switching to Cr(VI)-based ECCS that is readily available from numerous suppliers in the EU and the rest of the world. This would have significant operational and cost implications for them but in reality would be their only option, given that there are no suitable alternatives to chromium trioxide at the present time.

2.5.4 Regulatory context

In addition to the above, the applicant must also ensure its products meet regulatory requirements and applicable standards relevant to each of the markets that it supplies. While this includes non-UK markets such as the EU and North America, the following information focuses on UK requirements to illustrate just this part of the regulatory backdrop against which the applicant operates.

2.5.4.1 Food packaging legislation

Following the UK's exit from the EU, the UK retained much of the EU's regulatory framework for food contact materials (FCM), which includes ECCS. The primary legislation governing FCM in the UK is the Materials and Articles in Contact with Food Regulations 2012, which implements provisions from assimilated EU Directives and provides for the enforcement of assimilated EU Regulations. These include Regulation (EC) No 1935/2004 which sets out general safety requirements for materials intended to come into contact with food, and Regulation (EU) No 2023/2006 on good manufacturing practice for materials and articles intended to come into contact with food.

FCM regulations apply to all materials and articles intended to come into contact with food, including packaging, containers, processing equipment and coatings, and aim to ensure that such materials do not transfer harmful substances to food and drink or compromise their quality. The overarching principle is that materials must be manufactured in accordance with good manufacturing practice (GMP) and must be safe under their intended conditions of use. For the purposes of this AfA, this means the applicant must consider very carefully any changes to the current composition and manufacturing processes for its products, as these must be assessed for their potential impact on food safety and quality.

Duties under the legislation apply to all actors in the supply chain, including manufacturers, importers, processors and distributors. These dutyholders must ensure that their materials comply with applicable compositional and migration limits, maintain documentation demonstrating compliance (known as a Declaration of Compliance, or DoC) and cooperate with enforcement authorities such as the Food Standards Agency (FSA) or local authorities. Businesses must also ensure traceability of materials throughout the supply chain and be prepared to take corrective action if non-compliance is identified.

In addition, food packaging labelling is also highly regulated, governed by a combination of retained EU law and domestic regulations, primarily Regulation (EU) No. 1169/2011 on the provision of food information to consumers (the FIC Regulation). While the labelling requirements themselves do not regulate the type of packaging material, they do have practical implications for material selection. Steel containers, such as food cans, aerosols and closures, must be compatible with label printing or adhesive labels that can withstand the rigours of production, transport and storage. This means the surface finish of the steel must be suitable for ink adhesion or label application.

2.5.4.2 Packaging waste

Following the UK's exit from the EU, the UK has introduced a new framework for packaging and packaging waste under the Producer Responsibility Obligations (Packaging and Packaging Waste) Regulations 2024, which replaces earlier EU-derived rules. These regulations are part of the UK's Extended Producer Responsibility (EPR) scheme, which shifts more of the financial and operational burden of managing packaging waste onto producers. Under this framework, businesses that place packaging on the UK market, including manufacturers, packers/fillers, importers and brand owners, must register with the appropriate environmental agency, report detailed data on the packaging they handle, and meet recycling and recyclability assessment obligations.

For a company like the applicant, which manufactures materials (such as ECCS and ETP) that are used by downstream customers to make packaging, the obligations under the packaging waste regulations are more nuanced. The applicant itself does not place finished packaging on the market, so it is not directly classified as a packaging producer under the EPR scheme. However, the applicant's customers will have duties and so the applicant may be required to provide data and compliance information to its customers, particularly under the new requirements for recyclability assessments and traceability. Changes to raw materials prior to their conversion into packaging (such as the applicant's products) will therefore impact obligations under the legislation and must be carefully considered.

2.5.4.3 Pack testing

Pack testing in the food and drink packaging sector refers to a series of technical evaluations carried out to ensure that packaging performs as intended throughout its lifecycle, from filling and sealing, through transport and storage, to final use by the consumer. Pack testing is not explicitly required under UK food safety legislation but it plays a critical role in demonstrating compliance with broader legal obligations related to food safety, packaging suitability and consumer protection. Pack testing is essential because it helps manufacturers verify that packaging meets regulatory requirements, protects the product effectively and performs consistently across production batches. It also supports brand reputation by ensuring that consumers receive products in good condition, with no leaks, spoilage or contamination. In the food and drinks industry, where shelf life and safety are tightly regulated, inadequate packaging performance can lead to costly recalls, legal liabilities and damage to consumer trust.

The evaluation of new packaging materials is carried out in several stages. Initially, screening tests are conducted to assess performance. These are typically **accelerated tests**, designed to simulate the effects of long-term storage within a shorter timeframe. To achieve this, test conditions are intensified, such as by increasing the temperature or using food simulants, to compensate for the reduced duration. However, a limitation of accelerated testing is that the intensified conditions can influence the failure mechanisms, potentially leading to results that do not fully reflect real-world performance. Despite this, accelerated tests are particularly valuable in the early stages of material development, where the primary goal is to compare different materials and identify those with the best relative performance.

If a material performs well in these initial tests, it proceeds to the next phase: **real-time or real-conditions testing**, also known as direct determination. This phase is essential because it has been shown that performance under normal storage conditions cannot be reliably predicted from accelerated testing alone. For both product integrity and food safety, real-time testing is critical. Real-time testing involves filling cans with a variety of representative contents, storing them at ambient and elevated temperatures, and inspecting them at regular intervals, typically every six months, over a period of two to four years. The exact duration depends on the customer's requirements and the expected shelf life of the food products. However, there is a growing trend toward longer testing periods and it is common for testing periods to now last for four years.

These tests are usually conducted by can-makers, sometimes in collaboration with their customers. The applicant does not carry out pack testing themselves because they do not know what the end use will be for the products they produce.

When there is a change to packaging materials, such as the introduction of a new substrate or coating, pack testing becomes even more critical. Any modification can affect the packaging's mechanical, chemical or barrier properties. Therefore, a full validation process is typically required, including compatibility testing with the product, migration testing for food contact compliance and performance testing under expected storage and transport conditions. Regulatory bodies and quality assurance teams often require documented evidence that the new material performs at least as well as the previous one, ensuring continuity of safety and functionality.

2.5.4.4 Standards and certifications

A range of standards and certifications apply to packaging steel producers like the applicant, to ensure that their products are safe, compliant and suitable for use in food packaging. These standards cover not only food safety and hygiene but also religious, environmental and quality management considerations.

One of the most significant certifications is the **BRCGS Global Standard for Packaging Materials**, which the applicant’s Trostre site holds at Grade AA+, the highest level achievable in an unannounced audit. This standard, recognised by the Global Food Safety Initiative (GFSI), ensures that packaging materials are manufactured in hygienic environments and meet rigorous safety and quality criteria. It is particularly important for materials intended for direct or indirect food contact and is often a prerequisite for supplying major food brands and retailers.

In addition to BRCGS, the Trostre site has obtained **EHDA Halal** and **KLBD Kosher** certifications, which confirm that its products meet the dietary and ethical requirements of Muslim and Jewish consumers respectively. These certifications are increasingly important in global markets where religious compliance influences purchasing decisions and regulatory access.

ECCS itself is manufactured according to specific requirements outlined in various standards, such as BS EN 10202:2022 (*Cold reduced tinmill products: electrolytic tinplate and electrolytic chromium/chromium oxide coated steel*) and BS EN 10335:2024 (*Steel for packaging. Flat steel products intended for use in contact with foodstuffs, products or beverages for human and animal consumption. Non alloyed electrolytic chromium/chromium oxide coated steel*). These standards specifically define ECCS as a hexavalent chromium process and ECCS-RC (also known as TCCT) as a trivalent chromium process. This means if the use of hexavalent chromium is no longer permitted, the applicant could no longer supply ECCS and would need to obtain approval from their entire customer base to supply ECCS-RC instead, and update all relevant certifications and Declarations of Conformity (DoCs). Both standards clearly state that the customer must specify whether they require ECCS or ECCS-RC, as the two products are not interchangeable.

The above certifications and standards exist to ensure that products brought into contact with food are safe, traceable and manufactured under controlled conditions. They provide assurance to regulators, customers and end users that the materials will not compromise food safety or quality. They also support market access, brand reputation and legal compliance.

If a manufacturer like the applicant makes changes to its products, such as introducing a new coating or modifying a surface treatment, it may trigger the need for revalidation of existing certifications. This could involve updated migration testing, risk assessments and audits to confirm continued compliance with the requirements of certification standards. Failure to reassess and revalidate could result in the suspension or withdrawal of certifications, potentially affecting customer relationships and market access.

3. Analysis of alternatives

3.1 Applied-for use scenario (AfUS)

3.1.1 Process description

ECCS was initially developed in 1955, but was first applied commercially by the Toyo Kohan Co., Ltd in Japan in 1961. The product is also known as tin free steel (TFS) or by its Toyo Kohan trade name of Hi-Top. The process was first introduced at Trostre in the late 1960s, by conversion of the no. 1 ETL (electrolytic tinning line). Subsequently, in the 1970s, the no. 4 ETL was converted to a dual-purpose line, incorporating both ECCS and ETP sections. More recently, with the closure of the no. 1 line in 1994, the no. 4 line has been further modified to become a dedicated ECCS line and is now referred to as ECCS4.

The production process of ECCS in Trostre is an integrated, multi-step process. The feedstock material (HRC) for the production of ECCS was historically supplied from the applicant's Port Talbot site although, following the closure of the blast furnaces at Port Talbot in 2024, the applicant is sourcing HRC from elsewhere. Trostre will resume being supplied with HRC by Port Talbot, [redacted], when EAF-based steelmaking commences at Port Talbot, anticipated to occur late 2027 or early 2028.

ECCS manufacturing involves a series of process steps, only one of which (electroplating) involves the use of chromium trioxide. Between each process step, the coils are unwound and rewound again to move to the next line. A continuous operation is achieved by automatically welding the leading end of the new coil to the trailing end of the previous one. The different steps of the steel plate production process are:

1. **Pickling**: to remove the surface oxides formed during the hot rolling coil process, the steel is passed through a series of tanks containing an aqueous solution of sulphuric acid in the pickling line.
2. **Cold reduction**: to reduce the coils down from a thickness of typically 2mm down to any thickness ranging between 0.61mm and 0.16mm.
3. **Continuous or batch annealing**: Annealing is a controlled process of heating and cooling which gives the steel its required ductility, strength and hardness.
4. **Temper rolling or double reduction**: this operation gives the steel the final mechanical properties and flatness, as well as the customer's required surface finish.
5. **Electroplating**: An electric current is applied when the coils pass through tanks with Cr(VI) electrolyte, resulting in a precise deposition of chromium metal (Cr(0)) and chromium oxide (Cr(III)) on each side of the strip. This step is explained in more detail below as this is relevant for the use of chromium trioxide.
6. **Preparation for storage and dispatching**: The final product is delivered in coils or cut into flat sheets depending on customer needs. Automatic quality checks are done before cutting into sheets and a final visual inspection is performed before being stacked for packing and dispatch.

After the final step at Trostre, there is the further option of applying a polymeric coating (to make Protact products), which can occur at Trostre itself or at other Tata Steel sites in the EU (Ijmuiden in the Netherlands or Duffel in Belgium). Otherwise, a further lacquering layer will be applied downstream by the applicant's customers.

The electroplating step, like other process steps, is a continuous process. Production involving the following process steps, illustrated in overall terms in Figures 19, 20 and 21 below.

[redacted]

***Figure 19**: Manufacture of ECCS: process flow*

[redacted]

***Figure 20**: Manufacture of ECCS: three-dimensional diagram*

[redacted]

***Figure 21**: Block diagram of ECCS line (Cr(VI)-related sections are highlighted in red)*

In the **entry section**, the steel coil is unwound and cut to appropriate width before it passes through to the different treatment tanks. A typical blackplate coil weighs 19.2 tonnes and has average dimensions of 985mm width x 0.22mm thickness (gauge) x 11,287m length. (By contrast, finished coils typically weigh 9.82 tonnes with average dimensions of 970mm width x 0.22mm gauge x 5,860m length. The differences are because HRC weights are governed by the size of the slab cast and ECCS coils by the customer reel/crane/forklift capabilities.)

The **cleaning section** consists of five tanks – [redacted] cleaner 1 and 2 electrolytic tanks, and two rinsing tanks. Cleaning consists of treating the strip with [redacted] then cleaning in two electrolytic tanks containing [redacted]. This is followed by rinsing by spraying water with a low concentration of sulphuric acid in two rinsing tanks. All baths are connected to individual circulation tanks situated in the basement of the production area.

The **pickling section** consists of four tanks. Sulphuric acid pickling is used to remove the iron oxides (rust) formed on the surface of the strip and to lightly etch the strip, providing a clean surface for subsequent electroplating. The strip is treated with a pickling solution (an aqueous solution of sulphuric acid) in two tanks in the pickling section. The pickling tanks are followed by two rinsing tanks to remove excess of acid.

The **chromium plating section** consists of a number of vertical tanks arranged in tandem (see Figure 20) so that any point on the strip passes into each tank consecutively and the chromium coating thickness is increased in successive pass-throughs. [redacted] There are [redacted] tanks in the plating section that contain Cr(VI) electrolyte.

[redacted]

***Figure 22**: Tandem arrangement of plating tanks*

[redacted]

The steel strip is then **electroplated**. The ECCS electrolyte is composed of chromic acid [redacted] The electroplating section consists of [redacted] chromium plating tanks, each measuring approximately [redacted] (at the liquid level) and containing approximately [redacted] of electrolyte. Each tank is connected to a common recirculating system (situated in the basement of the production area). [redacted]

[redacted]

[redacted]

***Figure 23**: Schematic diagram of chromium plating tank*

[redacted]

In the **post-chromium plating section**, the strip passes through two rinsing tanks with hot water [redacted] to remove remaining Cr(VI) electrolyte and impurities, followed by [redacted] squeeze rolls and a hot air dryer. A thin film of lubricant is applied to minimise subsequent damage by abrasion, to facilitate sorting, handling, mechanical feeding and fabricating operations and to aid in lacquering and printing operations. After inspection (a visual inspection by an operator and a continuous in-line inspection system), the strip is rewound for further processing (e.g. polymer coating application) or supply to the customer.

3.1.2 Key functionalities and performance standards

Cr(VI) is used in the coating of steel as the electroplating process imparts specific properties required for the steel's final applications, such as in packaging materials. Since the majority of the applicant's ECCS is used in packaging (around 86%), the functional requirements for packaging are the primary consideration when evaluating potential alternatives.

The purpose of applying a chromium coating to steel plates is to create a corrosion-resistant layer, comprising metallic chromium (Cr(0)) and chromium oxide (Cr_2O_3), and to provide a suitable surface for subsequent processing, such as the application of lacquer or laminate. This structured layer, in combination with the applied organic coating, ensures the necessary oxidative and chemical resistance throughout the lifecycle of the packaging material.

Potential alternatives are assessed not only for their suitability in the final application but also for their compatibility with the entire packaging unit (e.g. a can, which will include closures) and the broader metal packaging manufacturing process. For example, ECCS must be compatible with the lacquer systems applied to ensure essential qualities such as corrosion resistance, shelf life and visual appearance.

Chromium-coated steel plates (ECCS) are standardised products manufactured according to specific requirements outlined in various standards, such as BS EN 10202:2022 (*Cold reduced tinmill products: electrolytic tinplate and electrolytic chromium/chromium oxide coated steel*). Customer processes are finely tuned to these specifications, meaning any changes to the ECCS manufacturing process must be carefully evaluated for their impact on both the customer's production processes and the final product's properties.

A significant portion (approximately 30%) of ECCS used in packaging is dedicated to food packaging. Even non-packaging uses are often intended for food contact, such as bakeware. This means the technical approval standards for food contact remain a dominant factor in determining the feasibility of any alternative, i.e. any potential substitute must meet food-contact requirements as well as other key functional requirements. In addition, different types of food create varying conditions within the packaging, requiring the material to withstand a range of chemical and physical stresses. The demanding conditions of canned food production and the need for long shelf life further increase the performance requirements of the steel. Therefore, any potential alternative must be tested in collaboration with food packaging manufacturers and fillers.

The combination of the steel base material and the multi-layer organic coating provides several critical properties, including mechanical strength and stiffness, cold formability, strong lacquer adhesion and aesthetic appeal. Key functional requirements also include corrosion resistance during storage and transport, and chemical resistance to food products to ensure safe preservation of food and beverages.

Different stages in the lifecycle of the steel impose different requirements. A distinction must be made between the steel strip before packaging manufacture and the final, filled packaging. Steel strip may be stored for up to a year before use and must resist corrosion during this period. Once formed into cans, the material must provide sufficient chemical resistance to the contents. The chromium coating alone is not enough; an organic coating or lacquer will be applied to form a structured barrier that prevents adverse interactions between the packaging and its contents. Such interactions may include oxidation (due to oxygen in the food or headspace) or the diffusion of chemical compounds through the organic layer.

The following overarching requirements have been identified for evaluating suitable alternatives to Cr(VI) in the electrolytic process used to form Cr(0) and Cr(III) layers on steel:

1. **Corrosion resistance** of the steel plate prior to use
2. **Adhesion**, i.e. a suitable surface for organic coating application
3. **Chemical resistance** to the contents of the packaging
4. **Compatibility** with downstream processes, including heat resistance and formability
5. **Suitability for food contact** (in compliance with food contact regulations)
6. **Visual properties**, including aesthetics, brightness, and overall appearance
7. **Scalability and stability** of the production process for high-volume manufacturing
8. **Sustainability**, in particular, the ability to recycle

These functional requirements are explained in detail below and have been used as the basis for screening potential alternatives. Most of these functionalities are highly interconnected with each other and are due to the characteristics of the coating deposited from Cr(VI). Therefore, it is essential that a potential alternative sufficiently fulfils every minimum requirement.

3.1.2.1 Corrosion resistance

Corrosion resistance, i.e. the ability of a material to withstand gradual degradation due to oxidation in its environment, is a critical requirement. In this context, it refers to the resistance of plated steel to ambient air exposure during transport and storage, prior to the packaging manufacturing process.

The combined layer of metallic chromium (Cr(0)) and chromium oxide (Cr_2O_3) on the surface of chromium-plated steel acts as a physical barrier against oxygen and moisture. This barrier prevents the diffusion of oxygen and inhibits further oxidation of the steel, thereby protecting it until it undergoes further processing.

Corrosion resistance is verified through controlled storage testing. The following tests are conducted on ECCS without an organic coating:

- Accelerated corrosion test: Samples are placed in a humidity chamber at 40°C and 90% relative humidity for one week. Visual inspections are carried out daily.
- Long-term evaluation: Regular inspections of stored material over time.

In practice, steel coils are typically stored at customer sites for around three months before being used in packaging production and filling. However, this period can be extended, e.g. if harvest yields are lower than expected when the steel was originally ordered. In general, packaging materials are used within one year of production.

Corrosion resistance during storage and transport is essential not only at customer sites but also within Tata Steel's own operations. For instance, ECCS is sent to Tata Steel's sites in IJmuiden (the Netherlands) and Duffel (Belgium) for application of a laminate coating to make Protact products. This means that ECCS must be transported, often by sea, between sites. This makes corrosion resistance of ECCS prior to the application of the organic coating a key functional requirement.

3.1.2.2 Adhesion

The second key function of the Cr(0)/Cr(III) layer is to provide an optimal surface for strong adhesion of organic coatings. These coatings primarily offer chemical resistance, protecting against degradation caused by chemical reactions with the environment, and enhance the downstream processability of ECCS material. The chromium metal and chromium oxide layers alone do not provide sufficient chemical resistance throughout the service life of the packaging. Therefore, an additional organic coating is essential. For this layered system to be effective, the organic coating must adhere perfectly to the base material. This is made possible by the mechanically stable Cr(0)/ Cr_2O_3 layers, which form a suitable surface for coating, unlike the corrosion products of steel which are mechanically unstable and unsuitable for adhesion.

Beyond chemical resistance, the organic coating also addresses a challenge posed by the chromium layer itself: its hardness. The Cr(0)/Cr_2O_3 surface is very hard and can cause wear on can-making machinery at customer sites. Applying an organic coating significantly improves the processability of ECCS in manufacturing equipment. Even in applications where chemical resistance is less critical, organic coatings are still applied to enhance processability. In some cases, the surface properties of the organic coating provide additional functional benefits, such as anti-stick properties. In these applications, excellent adhesion to the base material remains essential. Additionally, the organic coating contributes to the decorative appearance of the can or metal packaging.

There are two main types of organic coatings used:

- Laminates: the applicant primarily uses its in-house Protact laminate, available in various thicknesses.
- Lacquers: these are selected by customers, resulting in a broader range of materials and a wider testing scope.

The introduction of new BPA-free lacquers adds complexity to testing, as these are often evaluated alongside other changes, making interpretation of results more challenging. Regardless of the type of organic coating, excellent adhesion is critical.

The organic coating can only perform its protective and functional roles if it remains firmly adhered to the steel surface. Adhesion strength depends on both the properties of the ECCS substrate and the organic coating. The bond must be strong enough to withstand mechanical deformation during can and closure manufacturing, as well as the conditions encountered during use, such as sterilization or baking. ECCS offers particularly strong adhesion, enabling efficient can-making processes that involve significant mechanical deformation of the coated steel. For Protact, the substrate must also withstand high temperatures (200–300°C) during polymer layer application.

Adhesion is evaluated through several methods:

- Simulation tests using substances that mimic real-use conditions.
- Pack tests to assess long-term coating adhesion.
- Can production test runs to evaluate adhesion under mechanical stress during manufacturing.

For lacquer coatings, adhesion is tested using a cross-hatch test (ISO 2409:2020 – Paints and varnishes: cross-cut test). A polyamide adhesive tape is pressed onto the coated surface and removed after two minutes. The degree of delamination is assessed using the Gitterschnitt scale, ranging from 0 (no delamination) to 5 (complete delamination). Adhesion is also tested after sterilization using different media (e.g. 121°C for 60 minutes with lactic acid and/or cysteine) to simulate real-world conditions.

***Figure 24**: Lacquer adhesion test showing insufficient adhesion (left) and good adhesion (right) (source: Marmann et al., 2011)*

For laminated steel plates, 180° T-peel tests are used to evaluate adhesion strength. The procedure begins by immersing the can flange in an 18% hydrochloric acid solution to partially dissolve the steel base, creating an initiation point for peeling the coating. Next, 15 mm-wide strips are cut from the can wall. Using a tensile tester, the coating is peeled away at a 180° angle.

The peel force, defined as the average force required to peel the coating over a 10-30 mm length, is measured in newtons per 15 mm (N/15 mm). This value serves as an indicator of the material's delamination potential.

While excellent adhesion in lamination is generally a good indicator of adhesion performance for other coating systems, it is not definitive. Therefore, testing must still be conducted using the actual organic coating intended for the application.

Verification of substrate stability is also performed during Proact lamination testing to ensure consistent performance.

3.1.2.3 Chemical resistance

Chemical resistance refers to a material's ability to withstand gradual degradation caused by chemical reactions with its environment. In this context, the entire layered system, comprising both the metallic and organic coatings, must be evaluated as a whole. The 'environment' refers to the contents of the packaging, which can trigger various chemical reactions, such as oxidation from the headspace or food, acid-base reactions or diffusion of substances through the organic layer.

Some canned products are highly corrosive due to their acidic or alkaline nature, strong polarity, oxidizing properties, or high salt concentrations. These contents can aggressively attack the plated steel, and the resulting oxidation products – containing elements like iron (Fe), sulphur (S) and phosphorus (P) – may negatively affect the organoleptic (taste, smell, appearance) properties of the food.

The chromium layer, together with the organic coating, protects the steel by forming a physical barrier and modifying the surface reactivity. This layered system delays the onset of chemical reactions and slows their progression once initiated.

Chemical resistance is assessed through exposure tests followed by visual inspection for signs of damage, such as pitting. Testing typically includes:

- Controlled storage conditions with subsequent visual inspection.
- Heat treatment of cans (typically above 100°C) to simulate sterilization.
- Long-term pack tests, ranging from 2 weeks to up to 4 years, to evaluate performance over the expected shelf life of the product.
- Sterilization resistance tests using real or simulated media (e.g. salt, acetic acid, reducing agents, sulphur compounds, cysteine, lactic acid) at 130°C for 1 hour.

After testing, cans are inspected and rated based on the presence and severity of defects, with scores assigned to quantify chemical resistance performance.

3.1.2.4 Compatibility with downstream processes

Since a significant proportion of ECCS packaging material is used in food packaging, the sterilization process, conducted after can formation, is a critical boundary condition. One of the key advantages of metal packaging is its ability to undergo simultaneous sterilization of both the packaging and its contents. To support this functionality, the packaging must be able to withstand the conditions of sterilization without compromising its integrity.

This requirement is particularly stringent for drawn and redrawn (DRD) cans, which undergo substantial mechanical deformation during production. The final material, including the organic coating, must maintain its performance and adhesion throughout these deformation processes. In other applications, such as bakeware, the organic coating must also demonstrate strong adhesion and stability at elevated temperatures.

Heat resistance of the coated material is verified by exposing it to relevant elevated temperatures in combination with mechanical deformation. The material must withstand both the high temperatures encountered during processing and those experienced throughout its lifecycle.

- Sterilization temperature target: 100°C to 130°C
- Performance criteria: No delamination or degradation of the coating, even after deformation

This ensures that the coated steel remains functional and safe for use in food packaging and other high-temperature applications.

3.1.2.5 Suitability for food contact

Food contact materials are regulated in the UK and internationally. While EU food contact legislation is broadly similar to that of the UK, the applicant's markets also include non-EU countries such as the US. One of the most frequently requested certifications by can-makers is compliance with the US Food and Drug Administration (FDA) regulations, due to the international nature of the food packaging industry. Clients often require FDA food contact compliance in addition to meeting UK and EU regulations because this ensures global market access and regulatory alignment.

Compliance is verified through composition checks, migration testing and adherence to approval procedures. Migration testing is typically conducted using migration cells, which ensure controlled and reproducible test conditions. The procedure involves:

1. Placing a sheet of the packaging material on a base plate.
2. Positioning a cylindrical ring over the sheet.
3. Adding a second sheet of packaging material on top of the ring.
4. Assembling the cell and filling the internal volume with a suitable liquid food simulant via access ports.

Figure 25*: Use of migrations cells (open on left, closed on right)*

After exposure to specified time and temperature conditions, the simulant is removed and analysed for potential chemical migration from the packaging material. This test helps determine whether the material complies with regulatory limits for food contact safety.

3.1.2.6 Visual properties

The visual appearance of ECCS, such as surface structure, colour and brightness, can significantly influence the final look of lacquered or laminated products. Even when coated, the base material can affect the visual outcome, especially when transparent coatings or laminates are used. Variations in appearance will influence the purchasing behaviour of the applicant's customers when considering alternative materials, as differences in the final product's look can be perceived as quality issues.

Although all ECCS is coated, many coatings and laminates are transparent, allowing the underlying surface to remain visible. As a result, any change in the base material's visual characteristics can still be seen after coating. Customers have reported that such changes, particularly in gloss or colour, can have significant operational consequences. For example:

- Automated visual inspection systems may misidentify changes as defects, leading to increased rejection rates or requiring time-consuming recalibration.
- Perceived defects, such as dullness or discoloration, may be mistaken for microbiological contamination, potentially damaging brand reputation.
- Consumer perception can also be affected, as visual appeal plays a key role in purchasing decisions.

Visual appearance is assessed through light reflection measurements to quantify gloss and brightness, and a visual inspection to detect any noticeable changes in surface appearance.

These evaluations help ensure that any alternative materials meet the high aesthetic standards expected by both manufacturers and end consumers.

3.1.2.7 Scalability and stability of the process

The production process for any alternative to ECCS must be compatible with stable, high-volume manufacturing. Packaging steel production is a high-throughput, highly automated, continuous process. Current production lines operate at speeds of up to [redacted] per minute. If an alternative material or process reduces throughput compared to the existing system, additional production lines may be required to maintain output levels, significantly impacting cost and efficiency.

In addition to throughput, process stability is essential. The quality of the chromium coating must remain consistent over time, which depends on the stability of the electrolyte used in the coating process. For example, the accumulation of impurities in the electrolyte must be minimised to prevent any negative impact on coating quality.

Suitability for high-volume production is verified through:

- Trial production runs on both pilot-scale and full-scale production lines
- Monitoring of line speed compatibility, coating quality consistency, and electrolyte stability

These trials ensure that any proposed alternative can meet the demands of industrial-scale manufacturing without compromising quality or efficiency.

3.1.2.8 Sustainability

Chromium trioxide plays a critical role in providing corrosion resistance, adhesion properties and chemical resistance, all of which are essential for the performance and longevity of ECCS used in food and beverage packaging. However, the assessment of alternatives must go beyond technical performance to address broader societal and environmental concerns, including sustainability.

Recyclability is a fundamental aspect of sustainability in the steel packaging sector. Steel is one of the most recycled materials globally and ECCS is designed to be fully recyclable within existing steel recycling streams. Chromium trioxide-based coatings, when properly managed, do not hinder this recyclability. Therefore, any alternative must be assessed not only for its ability to replicate the technical functions of chromium trioxide but also for its compatibility with established recycling processes. If an alternative introduces contaminants or requires separation processes that complicate recycling, it could undermine the circular economy benefits that ECCS currently offers.

Scrap steel is composed of products that have reached their end of life such as vehicles, machineries or ships, are no longer in use or demolished structures, old or broken domestic appliances such as refrigerators or washing machines, packaging as well as yield losses in the steelmaking processes. Used steel packaging can be put directly into furnaces and melted down to produce new steel an endless number of times with no loss of quality. The large volumes of steel produced in Europe every year (around 160 million tonnes) are already made with large amounts of scrap steel. No artificial incentive is needed to recycle.

This means permanent materials such as steel can be recycled over and over again without losing their key intrinsic properties, thus maintaining circular material loops. Such materials are, and will remain, at the heart of any proven and well-functioning circular economy. In addition, steel's magnetic properties mean that steel is easy to recover from any waste stream by using magnets.

In June 2024, Steel for Packaging Europe, formerly known as APEAL, confirmed a new record recycling rate for steel packaging, following the harmonised method for calculating packaging recycling rates within the EU. Independently verified figures published by Steel for Packaging Europe confirmed that 80.5% of steel packaging placed on the market was 'really recycled' in 2022 (see Figure 26). It follows the announcement in December 2023 that steel packaging had met its EU recycling rate target for 2025, four years ahead of schedule.

This announcement also represents a 2% increase on the 2021 recycling rate and confirms steel packaging remains the most widely recycled sales packaging material in Europe, which is testament to its unique properties and the collaborative efforts of stakeholders across the value chain towards reaching a 100% closed material loop.

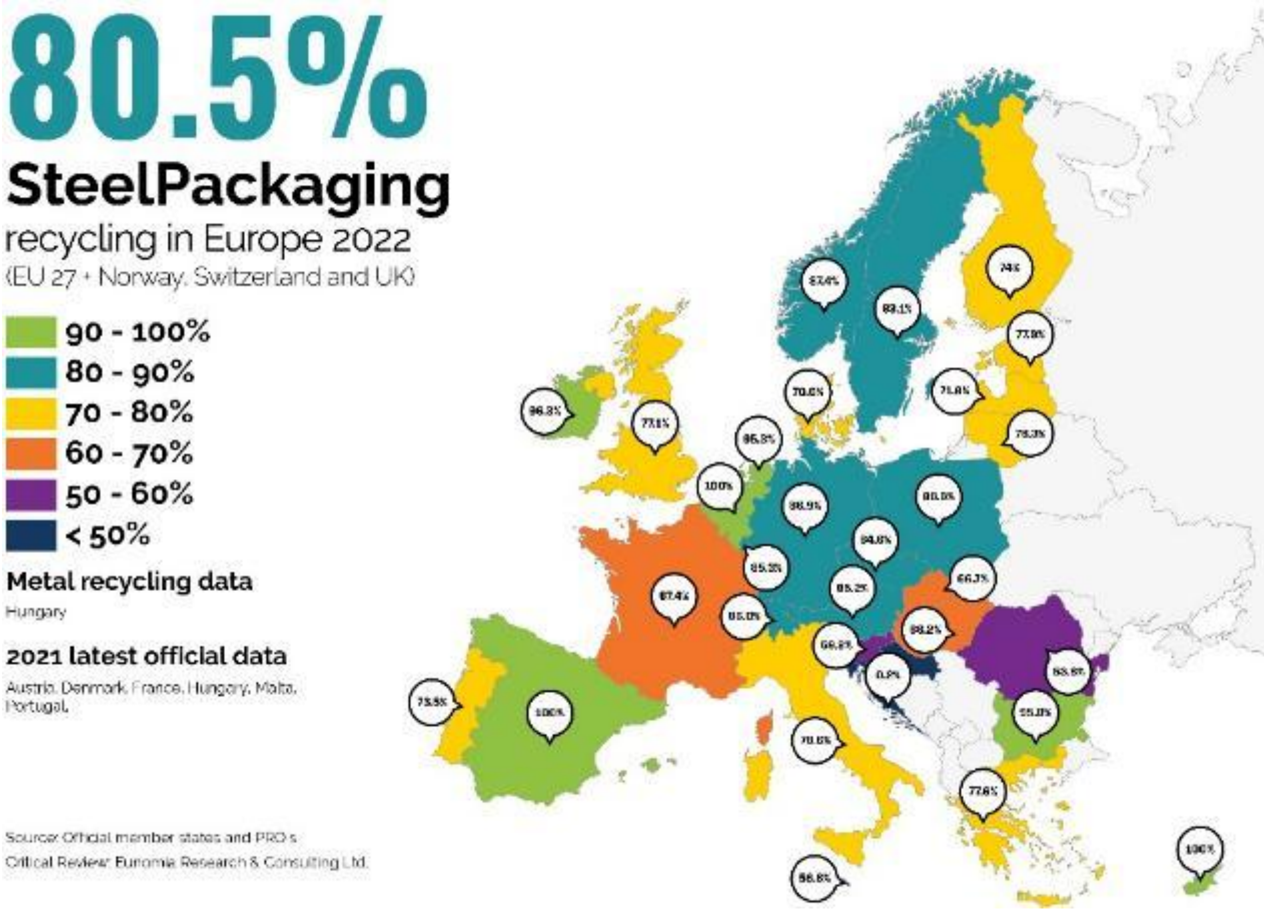

***Figure 26**: Steel packaging recycling rates across Europe (source: Steel for Packaging Europe)*

Global resources are limited, yet society's demands are increasing. Managing resources efficiently is therefore a top priority for the steel sector. Metal, as a highly recycled permanent material, saves raw materials, lowers energy consumption and reduces CO_2 emissions (see Figure 27).

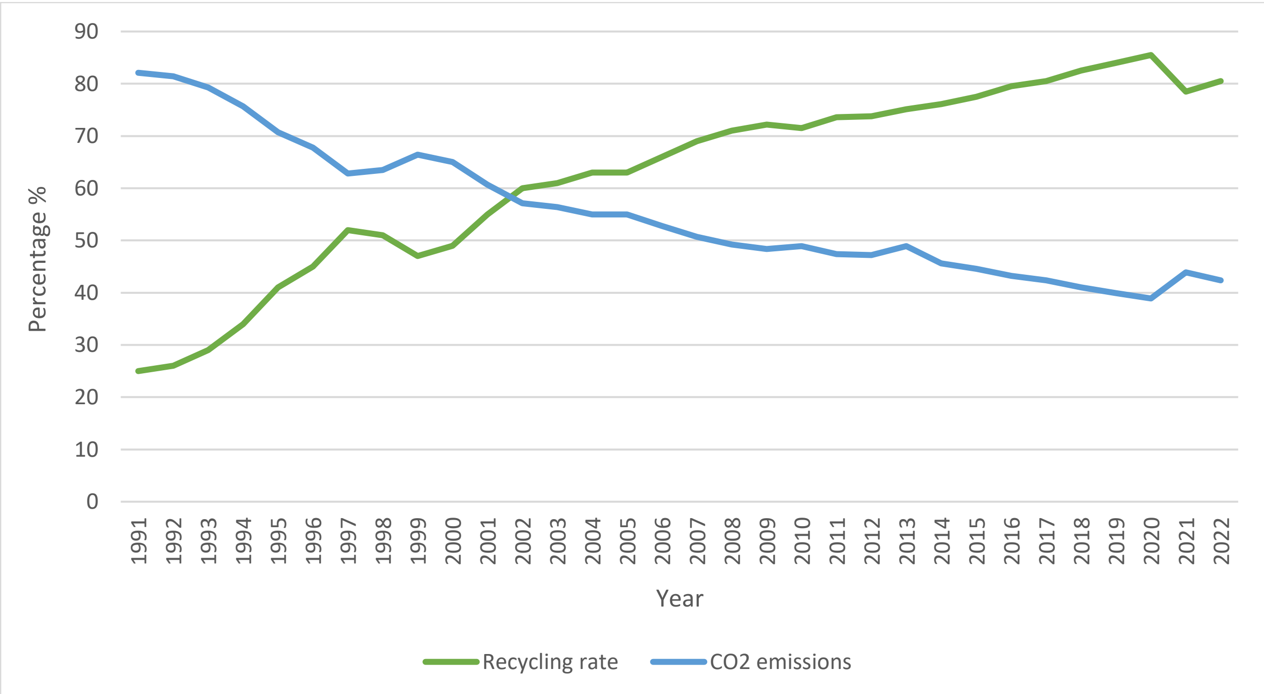

***Figure 27**: Relationship between CO_2 emissions and recycling rate (source: Steel for Packaging Europe)*

To assess whether an alternative is sufficiently sustainable, a life cycle assessment (LCA) approach can be employed. This includes evaluating the environmental impacts of the alternative across its entire life cycle, from raw material extraction and production to use and end-of-life disposal or recycling. Key indicators would include greenhouse gas emissions, energy and water use, toxicity and the potential for resource recovery. Additionally, the alternative should be assessed against chemical regulations (including REACH), occupational health and safety legislation, food contact materials regulations and environmental protection legislation. Stakeholder engagement is also crucial. This includes consulting with recyclers, downstream users and regulatory bodies to ensure that the alternative does not introduce unintended consequences in the supply chain.

3.1.3 Annual quantities

The tonnage information has been calculated on the basis of the quantity of chromium trioxide used in production each year. This is shown in Table 9 below. In recent years, the highest quantity consumed was [redacted].

[redacted]

***Table 9**: Tonnage (tonnes/year) of chromium trioxide used at the Trostre Works for the production of ECCS*

However, there is a possibility the consumption of chromium trioxide could increase in the future, e.g. in response to increased customer demand or in the event of an increase in surface area coated due to greater width of the finished product. To ensure sufficient headroom for any potential future production increase, the assessed total tonnage is [redacted] (public range: 100-150 tonnes) per year chromium trioxide or [redacted] per year Cr(VI).

3.2 Identification of alternatives

Since the discovery of chromium ores in Siberia over 250 years ago, chromium has become widely adopted in industrial applications. Initially used primarily in the paint industry during the early 19th century, its combination with steel began in 1865 with a patent for a precursor to stainless steel, involving the addition of metallic chromium to steel. The development of electroplating in the 1920s marked a turning point, with its use expanding rapidly, particularly during the 1940s wartime period.

Today, approximately 4% of all mined chromium ores are used in electroplating processes, including the production of ECCS.[9]

There are three main chromium plating processes used globally for ECCS production: a one-step vertical process (V-1); a two-step vertical process (V-2); and a one-step horizontal high current density process (HCD). All three processes use Cr(VI) electrolytes and result in a layered structure consisting of a metallic

[9] Guertin et al., 2004.

chromium (Cr(0)) layer topped with a chromium oxide (Cr_2O_3) layer. The applicant uses the two-step vertical process (V-2) which offers the best control over chromium oxide thickness.

ECCS production was first introduced at Trostre in the late 1960s, by conversion of ETL1 (an electrolytic tinning line). Subsequently, in the 1970s, ETL4 was converted to a dual-purpose line, incorporating both ECCS and ETP sections. This was converted into a dedicated ECCS line in the 1990s. Since its introduction, several key investments have been made to modernise ECCS production and improve product quality:

- 1985: Installation of a tension leveller to improve plate shape, reducing customer issues and increasing yield.
- 1990: Addition of edge trimmers to enhance plate edge quality.
- 1995: Conversion to a dedicated ECCS line. Simultaneously, plating tanks and chromate pipework were relined with PVDF (polyvinylidene difluoride) and PTFE (polytetrafluoroethylene) to prevent leaks of Cr(VI) electrolyte, improving safety, reliability and reducing unscheduled downtime.
- 1997: Upgrade to more advanced edge trimmers for further strip edge quality improvements.
- 1998–1999: Investment in a new tension leveller to further enhance coil shape.

As a result of these continuous improvements, the ECCS production line at Trostre remains technologically up to date and capable of operating efficiently for many years to come. While the core electrolytic chromium deposition process has remained largely unchanged since 1978, the supporting infrastructure and quality control systems have evolved significantly.

3.2.1 Efforts made to identify alternatives

The applicant has been searching for an alternative to the use of Cr(VI) in the manufacturing of ECCS for more than 15 years. In collaboration with thyssenkrupp and ArcelorMittal, a proposal was submitted in 2006 for a European project under the Research Fund for Coal and Steel. The proposal was approved and launched in 2007, titled '*Innovative Packaging Steel with Enhanced Adhesion to Organic Coatings Based on Nanostructured Interphases*' or IPSA. The project aimed to explore a chromium-free alternative to ECCS, focusing on low tin steel (LTS) containing 0.5-1.0 g/m^2 of tin. This initiative paralleled efforts to develop chromium-free passivation solutions for electrolytic tinplate (ETP).

The project ran from 2008 to 2011 and investigated various LTS-based steel-coating systems at laboratory, scale-up and pilot levels. These systems were compared with ECCS in application studies using a range of lacquers and laminates to reflect the diverse applications of ECCS in the European market. The project focused on five potential alternatives:

1. Tin phosphate coating via electrochemical application
2. Titanium oxide/hydroxide (TiOx) coating via electrochemical application
3. Siloxane-based coating via spray application
4. Silicate and silane-based coating via spray application
5. ZrO_2/TiO_2 oxide film applied through coil-coating, based on promising results in chromium-free ETP passivation

The IPSA project was documented in a comprehensive report by Marmann et al. (2013). The findings indicated that only one variant – non-reflown low tin steel (NR-LTS) – showed potential as a substitute for ECCS in lacquered applications. However, for laminated applications, LTS was found to be unsuitable due to poor adhesion of the polymer film, particularly after drawn and redrawn (DRD) deformation. While the IPSA project provided valuable insights, it did not ultimately identify a viable chromium-free alternative that could meet the requirements for both lacquered and laminated ECCS applications. Since the IPSA project concluded, its members have continued to search for alternatives individually.

[redacted]

[redacted]

In parallel, within the framework of the IPSA project, the applicant began screening for alternative conversion coatings. This marked the first mention of using a trivalent chromium (Cr(III)) electrolyte as a potential solution, alongside other chromium-free passivation technologies (e.g. Zr/Ti-based systems used for ETP). The first Cr(III)-based conversion coating was tested in a two-step process: first, electrolytic deposition of a metallic chromium (Cr(0)) layer, followed by the formation of a chromium oxide (Cr_2O_3) layer. These tests, conducted at ArcelorMittal, did not yield sufficient corrosion resistance.

Based on internal expertise and patent research, the applicant decided to abandon the two-step approach and instead pursued a one-step Cr(III) electrolyte process, which showed promising results in laboratory scale testing. [redacted] focus shifted to blackplate with Cr(III) conversion coating, a technology now referred to as Trivalent Chromium Coating Technology (TCCT).

Figure 28*: Pilot coating line at IJmuiden for the Cr(III) coating process*

To support further development, a pilot coating line was constructed in IJmuiden in 2011 (see Figure 28), which is where Tata Steel's R&D centre for packaging is located. Attempts to optimise the TCCT electrolyte followed, including testing of various complexing agents. Potassium chloride was initially used to enhance electrolyte conductivity but was later replaced with sodium sulphate to avoid the formation of chlorine gas at the anode.

Positive tests at the laboratory scale and on the pilot line resulted in Tata Steel filing a patent for TCCT, which was granted in 2014. Convinced of the robustness of the invention, a commercial-scale TCCT production line in Ijmuiden was given commercial approval in 2015, which saw the introduction of a new TCCT plating module into the ETP/ECCS swing line in Ijmuiden, as the ECCS section of this swing line had not been in use since 2008. This began operation in 2016. Tata Steel then approached thyssenkrupp to propose their Cr(III)-based solution as a forward-looking alternative. A license for the process was sold to thyssenkrupp in 2015. Establishing a second supplier of TCCT-based packaging material was considered essential to encourage customer adoption of the new product. The licensing agreement included knowledge-share arrangements to ensure the TCCT process could be developed as quickly and efficiently as possible.

[redacted]

By 2020, a two-step process had been developed that addresses some, though not all, of these issues. This has enabled the use of TCCT material within a specific Protact market but for one end use only (for aerosols). Further work has been ongoing since 2020 to optimise the coating weight and surface appearance of the TCCT-coated substrate for this application.

As of 2025, there has still been no breakthrough with the Cr(III)-based TCCT process to enable it to replace the Cr(VI)-based ECCS process for the vast majority of applications. Trostre continues to supply ECCS to the Ijmuiden site to meet all its other Protact end-use requirements, for which TCCT is unsuitable. Ijmuiden has committed to maintaining the same level of ECCS support from the applicant through 2026, consistent with previous years.

Since the organisational split of Tata Steel Europe in 2021, routine knowledge exchange between the applicant and TSN has stopped. There are no longer shared systems and facilities. As a result, the applicant can no longer directly access Tata Steel Packaging's R&D facilities and research located at TSN (the IJmuiden Technology Centre, IJTC), which leads on the development of Cr(VI) alternatives. TSN has led the agenda and efforts to further develop TCCT. The applicant's plan has been to deploy TCCT in the UK once it can meet the performance requirements across the range of products and applications by purchasing the licence for the technology from TSN. However, this end is not in sight.

TCCT cannot be produced on the current ECCS production line at Trostre without major modifications, which would require significant downtime of the ECCS line. To avoid this downtime, the applicant's plans involve modifying another line in Trostre which is idle at present. To this end, the applicant has already developed a capital investment proposal to replace its ECCS production at the Trostre Works with TCCT, estimated at over [redacted] (public range: > £100 million). However, plans have not been given commercial approval due to the ongoing, significant issues with TCCT that would first need to be resolved.

The table below highlights the problems experienced with the development of the TCCT process and its current state of development as of 2024.

Application		Issues							
		Process			Product				
		Cr_2O^3 at high line speed	Electrolyte stability	Fe^{2+}/Fe^{3+} in electrolyte	Rust spots	Protact-PET adhesion	Protact PP adhesion	Lacquer adhesion	Ageing prior to lacquering
Lacquering	Bakeware					N/A	N/A	?	?
	Ends					N/A	N/A	*	*
	Closures					N/A	N/A	*	*
	2 piece cans					N/A	N/A	*	*
	Other					N/A	N/A	*	*
Lamination	Aerosol bodies						N/A	N/A	N/A
	Aerosol ends						N/A	N/A	N/A
	Ends/rings					?	N/A	N/A	N/A
	DRD cans						N/A	N/A	N/A
	DWI cans						N/A	N/A	N/A

* Adhesion was acceptable for some lacquers but not for others.
? means not tested
N/A = not applicable

Outcome	Good	Medium	Poor

***Table 10**: Issues experienced with the development of TCCT technology*

The table below provides a summary of R&D activities to date to replace the use of chromium trioxide for ECCS production.

Process	Period	Context	Results
LTS + chromium free passivation	2006-2014	IPSA – project	Problems with adhesion of lacquer or the PET coating and after multiple forming, corrosion problems
[redacted]	[redacted]	[redacted]	[redacted]
Cr(III) study	2008-2011	IPSA – project	Two-step process, problems with electrolyte stability and efficiency.
[redacted]	[redacted]	[redacted]	[redacted]

Process	Period	Context	Results
Pilot TCCT line In Ijmuiden	2011	R&D at Tata Steel	Promising first results, adaptation of electrolyte composition. Problems appeared with poor organic coating adhesion and corrosion resistance.
Patent filed for TCCT	2013	Patent of TCCT	Patent granted.
Full scale TCCT swing-line in Ijmuiden	2016	R&D at Tata Steel	Full scale line installed as swing line on an existing ETP line. Lacquer and laminate adhesion insufficient and deterioration of the end product over time.
Further improving the TCCT process	2016 onwards	R&D at Tata Steel	Adhesions problems and corrosion resistance causing inhomogeneity in layer (thickness and Cr/Cr_2O_3 balance) leading to poor adhesion.

Table 11*: Overview and timeline of R&D activities to date*

In addition to R&D activities, a number of sources of information (literature and websites) were screened in the development of this analysis of alternatives. In addition, the applicant has also reviewed data presented as part of other similar applications for authorisation that have already been made under REACH. The AoA for these applications are made publicly available on the ECHA and HSE websites and relevant documents were reviewed to ensure that potential alternative processes to Cr(VI)-based electroplating were considered (relevant AfAs are identified in Table 8 above). For the purposes of this AfA, all such alternatives have been assessed for the applicant's specific requirements, i.e. the use of chromium trioxide for the production of ECCS. It does not follow that reported alternatives that appear promising or even feasible for certain applications will be similarly promising or feasible for the applicant, given the highly-specialised nature of the applicant's activities.

3.2.2 Longlist of alternatives

The longlist of alternatives presented below represents the outcome of the efforts described above. These alternatives have been screened for technical limitations, economic considerations, regulatory / safety concerns and availability in order to achieve a realistic shortlist of alternatives. The screening was based on the key functionalities (see section 3.1.2 above) essential for adequate performance that are in scope of this AfA. Based on this screening, the alternatives are categorised either as shortlisted alternatives that will be assessed in further detail in this report or as rejected alternatives which are not considered further as potential alternatives at the present time.

Alternative considered	Commentary / justification	Shortlist?
Trivalent chromium (Cr(III))-based surface treatment (including TCCT)	As described in section 3.2.1, Cr(III) has been investigated as an alternative for some time. This has involved laboratory scale tests, pilot coating line testing and on a full scale swing line. A Cr(III)-based alternative has been qualified to produce Protact products for one application only (aerosols) and is currently being manufactured in the Netherlands. However, issues remain for all other applications which have not yet been overcome. The current main concern is the lack of adhesion of laminates after sterilization. Significant further development is required before Cr(III)-based alternatives can be regarded as technically feasible. However, Cr(III)-based alternatives remain the most promising potential alternative for the applicant and so, on this basis, are shortlisted for further assessment.	Yes

Alternative considered	Commentary / justification	Shortlist?
Low tin steel (LTS) with phosphate electrochemical application	This alternative (the H1 option in the IPSA report) is an electrochemical application with sodium hydrogenphosphate to form a coating of tin phosphate. It was tested at the laboratory scale only and not progressed further. The main issue was that there was no effect on tin oxide growth inhibition (insufficient corrosion resistance). Lacquer adhesion was also insufficient for white lacquer in certain conditions (e.g. with S-containing solution). Lamination with polymer was also insufficient. A solution to overcome the technical problems was not identified. This alternative is not considered technically feasible and is therefore not being considered further.	No
Low tin steel (LTS) with TiOx electrochemical application	This is an electrochemical application with titanium oxide sulphate (the H2 option in the IPSA report). The final coating consists of titanium oxide and hydroxide. It was tested at the laboratory scale only and not progressed further. The main issue was that the end product showed unacceptable staining, probably due to limited passivation and corrosion resistance of the LTS. No solution could be identified for this issue. This alternative is not considered technically feasible and is therefore not being considered further.	No
Low tin steel (LTS) with Ti/Zr	This alternative (the H5 option in the IPSA report) uses the same system as the passivation of tinplate (ETP) but with a substrate containing less tin. This alternative is based on titanium and zirconium salts with an organic component. A commercially available liquid solution is used as a protective ZrO_2 / TiO_2 oxide film and is applied by spraying-and-smoothing roll system. Coating trials with this liquid adhesion system were performed by an ECCS manufacturer in Europe using a pilot coating line. The alternative showed poor performance in corrosion resistance (inhibiting tin oxide growth) during static humidity storage. This was surprising since Zr/Ti oxide showed very good performance in this respect on regular tinplate (ETP). Pack test material and DRD cans were produced on a semi-industrial basis. Lacquer adhesion was found to be insufficient. In addition, the $FeSn_2$ layer formed at higher temperatures (200-270°C) required for Protact proved to be brittle leading to loss of adhesion between the steel base and the $FeSn_2$ layer. While the IPSA report considered this option as potentially meriting further development, the applicant rules out this potential alternative (a) because of there are fundamental issues in combination with Protact, and (b) because other alternatives seemed more realistic for further development.	No
Low tin steel (LTS) with Silicates + Silanes Coatings	In this alternative (the C3 option in the IPSA report), a liquid based on silicates is applied using a spray disc-squeegee process on LTS coils. This alternative was tested on a pilot coating line. On the positive side, this alternative managed to suppress tin oxide growth and had no effect on visual appearance. Lacquer adhesion was somewhat lower than ECCS, yet sufficient. However, the system failed for polymer adhesion (lamination). Although the IPSA report considered this option as potentially meriting further development, this option has not been taken forward by the applicant, because the estimated timescale for further development of the option was judged to be longer compared to other alternatives. Additionally, the lack of adhesion for polymer lamination such as Protact was a significant concern.	No

Alternative considered	Commentary / justification	Shortlist?
LTS with silane / siloxane coatings	In this alternative (the C2 option in the IPSA report), a liquid based on silanes is applied using a spray process on LTS coils. It has been tested on a pilot coating line. The alternative was found to have significant deficiencies because of (i) a lack of corrosion resistance (tin oxide growth), (ii) staining due to insufficient corrosion resistance, and (iii) insufficient adhesion for polymer coatings. This alternative is not considered technically feasible (by IPSA or the applicant) and is therefore not being considered further.	No
[redacted]	[redacted]	No
Boron carbide and nickel (II) salt	This alternative involves the electrodeposition of boron carbide in a nickel/phosphorous alloy matrix. The applied coating is said to be both wear resistant and corrosion resistant. This alternative was suggested during the public consultation for the initial AfA but was ruled out by the applicant. Areas of application made on the website of the technology provider did not include any mention of packaging applications and wear resistance is not required in packaging, nor is it desirable, as it would inhibit adhesion properties. The alternative would also not meet risk reduction requirements. The use of nickel coatings on packaging steels would create issues regarding food safety. In addition, boron carbide has been notified to the EU CLP C&L inventory by many notifiers as a category 1B reprotoxicant, meaning it meets the SVHC criteria. This alternative is therefore not being considered further.	No
Passivated ETP (electrolytic tin-plated steel)	For some packaging applications, it may be possible to use passivated ETP as an alternative to ECCS. However, ETP offers an inferior organic coating adhesion and cannot be used at the temperatures required to manufacture Protact. As described in section 2.2.5 above, ETP and ECCS are selected for packaging applications for different reasons and one cannot simply replace the other, so ETP would represent at best an alternative only for a limited range of applications currently served by ECCS. However, the main issue is that Cr(VI) is also involved in the passivation of the tinplate (the applicant holds a separate authorisation for this use). As such, there would be no reduction in risk compared to ECCS. This alternative is not technically feasible for all applications and it does not lead in a reduction of risk. It is therefore ruled out by the applicant.	No

Alternative considered	Commentary / justification	Shortlist?
Chromium free passivation alternative (CFPA)	CFPA is arguably considered as the most promising potential alternative to ETP which requires Cr(VI) for passivation. However, as described above in relation to ETP as a potential alternative to ECCS, ETP and ECCS are selected for packaging applications for different reasons and one cannot simply replace the other. This means CFPA (as an alternative to ETP) would represent at best an alternative only for a limited range of applications currently served by ECCS. In addition, the CFPA technology is not (yet) considered sufficiently technically feasible. One of the primary concerns with CFPA is its sensitivity to process conditions. Another issue is compatibility with downstream processes. Testing is also still mainly carried out using lacquers that contain bisphenol A. As CFPA presents only limited options for ECCS replacement and is not yet technically viable, it is therefore ruled out by the applicant.	No
No chrome coating, i.e. organic coating applied directly to steel substrate	This alternative involves bypassing the electroplating process entirely and attempting to apply the organic coating (lacquer of laminate) directly to the substrate, i.e. blackplate. The applicant has ruled this out as not technically feasible because of (i) lack of corrosion resistance (rust), (ii) insufficient adhesion for polymer and lacquer coatings (iii) cleanliness of the substrate (steel dust and rolling mix). It would lead to food / process contamination and so create significant issues in relation to product quality and food safety.	No

***Table 12**: Longlist of potential alternatives*

The above longlist considers alternatives that would still result in the production of metal packaging. In the broader sense, there are various other packaging materials available on the market both for food and non-food applications, e.g. aluminium, glass, plastics, paper and cardboard, cellulose and so on. Based on recent data from 2023-2024,[10] an approximate breakdown of the global packaging materials market by material type (based on revenue share) is depicted in Figure 29 below.

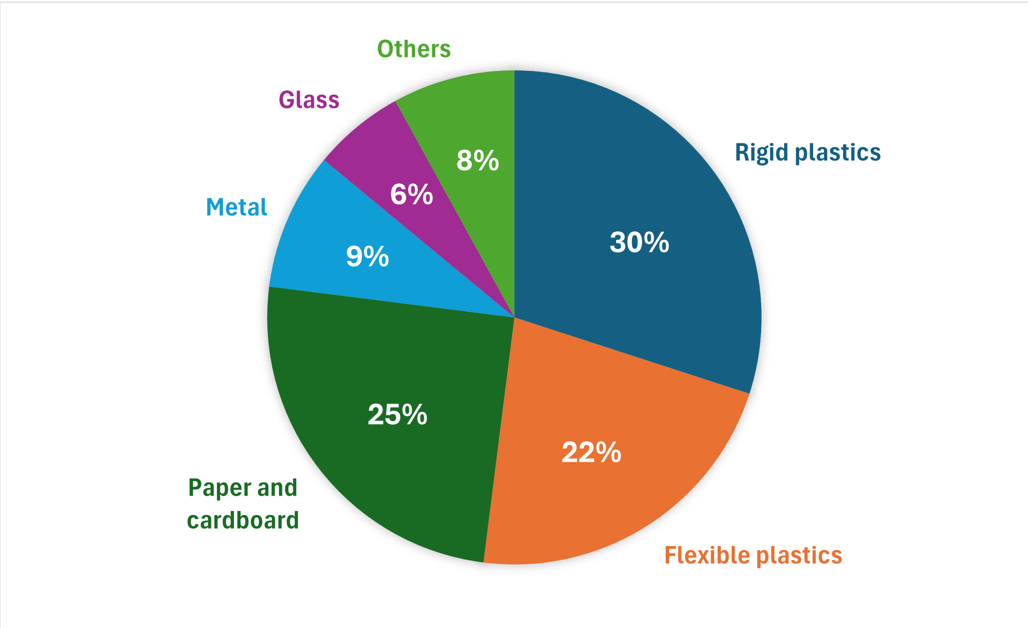

***Figure 29**: Approximate breakdown of the global packaging materials market by material type (based on revenue share) (source: Grand View Research)*

[10] Grand View Research, 2024.

As described in section 2.2.5 above, metal is often chosen as a packaging material for various reasons:

- **Heat resistance**: Alongside glass and aluminium, steel can withstand heat processing, allowing for the simultaneous sterilisation of both the can and its contents. In contrast, packaging materials like paperboard cartons (e.g. TetraPak) require aseptic processing, where the package and the product are sterilised separately.
- **Food preservation**: Food packed in steel, glass or aluminium retains a vitamin content equivalent to freshly prepared food, without the need for added preservatives.
- **Protection**: Steel packaging offers a complete barrier against light, water, and air, making it a secure solution for volatile products. It ensures the integrity of the contents throughout a long shelf life and provides superior resistance to solvents, which is particularly important for applications such as paint packaging.
- **Strength**: In terms of strength, steel is more robust than aluminium, while glass is brittle and prone to breakage. Although heavier than aluminium, plastic or paper/cardboard, steel is lighter than glass, making it more efficient to transport.
- **Sustainability**: Steel outperforms other materials in recyclability. It can be recycled indefinitely without any loss in quality, unlike glass which can only be recycled a limited number of times. In addition, steel scrap is a vital raw material in the production of new steel.
- **Cost**: From a cost perspective, steel packaging is more affordable than aluminium and, when factoring in the higher transport costs associated with glass, it becomes a cost-effective alternative. While plastic packaging is cheaper, it lacks several key attributes that steel offers: strength, long shelf life, compatibility with heat processing, and the ability to preserve vitamins.

Taken in the round, the specific properties of steel packaging create a distinct demand for steel in a market with many available packaging options. Due to its unique set of characteristics, steel packaging is often the only technically viable solution. Alternative materials like glass can only replace steel to a limited extent. If the applicant were to attempt to switch production to a different packaging material entirely and away from steel, their customers would not switch to non-steel alternatives; they would be forced to purchase it elsewhere instead, i.e. from abroad. Moreover, any such move would not be compatible with the applicant's wider business operations and would undermine their highly integrated UK business model. Indeed, the wider Tata Steel business would not support the required capital and infrastructure spend necessary for such a conversion, nor would Tata Steel easily be able to find new customers.

3.2.3 Shortlisted alternatives

Because of the clear advantages of steel packaging for specific applications, other packaging materials cannot be considered suitable alternatives. From Tata Steel's perspective, switching to non-steel packaging would require entirely different technologies, which would take significantly longer to implement and would be considerably more expensive compared to developing an alternative steel-based solution.

Given the more advanced stage of development of trivalent chromium-based technologies, including the TCCT process, any other surface treatment process would also require more time and investment to reach a comparable level of readiness. These alternatives are currently at a much earlier stage of development. As a result, Tata Steel has discontinued the development of all other alternatives and has focused exclusively on advancing Cr(III)-based processes, which have reached a higher level of maturity.

In this context, only **trivalent chromium-based alternatives** are carried forward for more detailed assessment and evaluation in this AoA.

3.3 Assessment of shortlisted trivalent chromium-based alternatives

3.3.1 Introduction

The aim of this AoA is to assess the feasibility of potential alternatives to the use of chromium trioxide for the manufacture of ECCS. The objective is to identify the most likely NUS for the applicant in the event that its use of chromium trioxide must cease, to provide input for the SEA and SP.

Article 60(5) of REACH provides that when assessing the availability of suitable alternative substances or techniques, all relevant aspects must be taken into account, including:

a) whether the transfer to the alternative would result in reduced overall risks to human health and the environment (as compared to the Annex XIV substance) taking into account risk management measures; and

b) the technical and economic feasibility in the UK of alternatives for the applicant for replacement of the Annex XIV substance.

The alternative must also be available for the applicant, i.e. it can be accessed in sufficient quantity and quality for substitution.

In this section, the shortlisted potential alternative is therefore assessed in terms of its technical feasibility, economic feasibility, potential for risk reduction and availability. A potential alternative process or technology **must fulfil all key functionalities** to ensure products can continue to be manufactured that provide sufficient corrosion resistance prior to use, adhesion and chemical resistance to the contents of the packaging. The alternative must also allow products to be made that are suitable for food contact, are compatible with downstream processes, have the necessary visual properties, are scalable and stable for high-volume production, and are sufficiently sustainable.

Any general attempt to offer products to the market using an inferior alternative without additional development would likely result in a critical loss of market share and sales, as customers would most likely switch to more reliable, proven and readily-available products made using Cr(VI)-based processes imported from outside of the UK.

The assessment focuses on technical feasibility in the first instance and, if the alternative is found to have critical technical weaknesses which means some of the key functionalities are not fulfilled, economic feasibility and other considerations do not then need to be assessed in detail. This is in line with the approach suggested in the ECHA guidance on authorisation[11] and aims to ensure a proportionate approach is taken to the AoA.

3.3.2 Process description

This alternative is based on the use of a Cr(III) electrolyte instead of a Cr(VI) electrolyte and will describe and discuss TCCT in particular. While Cr(III) plating processes operate on the same fundamental principle as Cr(VI) processes, i.e. the electrolytic deposition of chromium (Cr(0)) and chromium oxides (Cr(III)) onto a substrate, there are significant differences in the chemical composition of the electrolytes, the required additives, the operating parameters and the anode materials. Due to these differences, it is not possible to implement Cr(III)-based technology on an existing Cr(VI)-based ECCS production line without major modifications.

[11] ECHA, 2021(a), p45 and p81.

Electrodeposition from an electrolyte containing Cr(III) ions is highly complex and technically challenging. In Cr(VI)-based electroplating, the deposited metallic chromium naturally forms a thin, adherent chromium oxide (Cr_2O_3) layer upon exposure to air. This oxide layer is critical, as it provides the surface chemistry necessary for the subsequent strong adhesion of organic coatings such as lacquers or laminates. It acts as a bridge between the metallic substrate and the organic layer, ensuring durability and performance in packaging applications.

In contrast, Cr(III)-based electroplating typically results in the deposition of metallic chromium without the spontaneous formation of a chromium oxide layer. This absence weakens the adhesion of organic coatings. To address this, additional treatment steps are required to artificially create or enhance an oxide layer that can support strong adhesion.

Another challenge is the chemical behaviour of Cr(III) ions in aqueous solutions, where they tend to form the complex $[Cr(H_2O)_6]^{3+}$. Metallic chromium cannot be plated from this complex. To overcome this, a complexing agent (a formate) is used to destabilise the complex, forming $[Cr(HCOO)(H_2O)_5]^{2+}$, which allows for the deposition of metallic chromium.

Since 2019, work has been ongoing to establish the most effective process for achieving a suitable coating using trivalent chromium. The current method involves a two-electrolyte deposition process.:

- The first electrolyte, containing chromium sulphate, sodium sulphate, and sodium formate, enables the deposition of a predominantly metallic chromium layer.
- The second electrolyte, which contains only chromium sulphate and sodium sulphate, facilitates the deposition of a predominantly chromium oxide top layer. This oxide layer is essential for achieving the necessary adhesion between the substrate and a polymer or lacquer.

3.3.3 Technical feasibility

Although initial performance results from previous TCCT trials show potential, there are still a number of significant deficiencies that require further investigation. These include improving the stability of the process and the appearance of the coating.

Deposition of chromium onto the steel strip occurs due to a local increase in pH at the surface of the steel strip, which acts as the cathode. This pH shift results from the reduction of hydronium ions (H_3O^+) to hydrogen gas (H_2). As hydrogen ions are consumed at the steel surface, they are replenished through mass transfer of H_3O^+ from the bulk of the electrolyte. This transfer is facilitated by turbulence generated by the movement of the steel strip through the electrolyte.

The electroplating process is inherently complex due to the wide variety of Cr(III) complexes that can form in solution. These complexes are predominantly hexacoordinate, meaning they involve six ligands surrounding the chromium ion. As a result, multiple reaction pathways and mechanisms may be involved during the deposition of the chromium coating.

In the context of the TCCT process, three distinct regimes have been proposed for chromium deposition from a one-electrolyte system using a Cr(III)-formate electrolyte. These are indicated in Figure 30 below. Each regime is associated with different chromium complexes that may be present during the plating process.

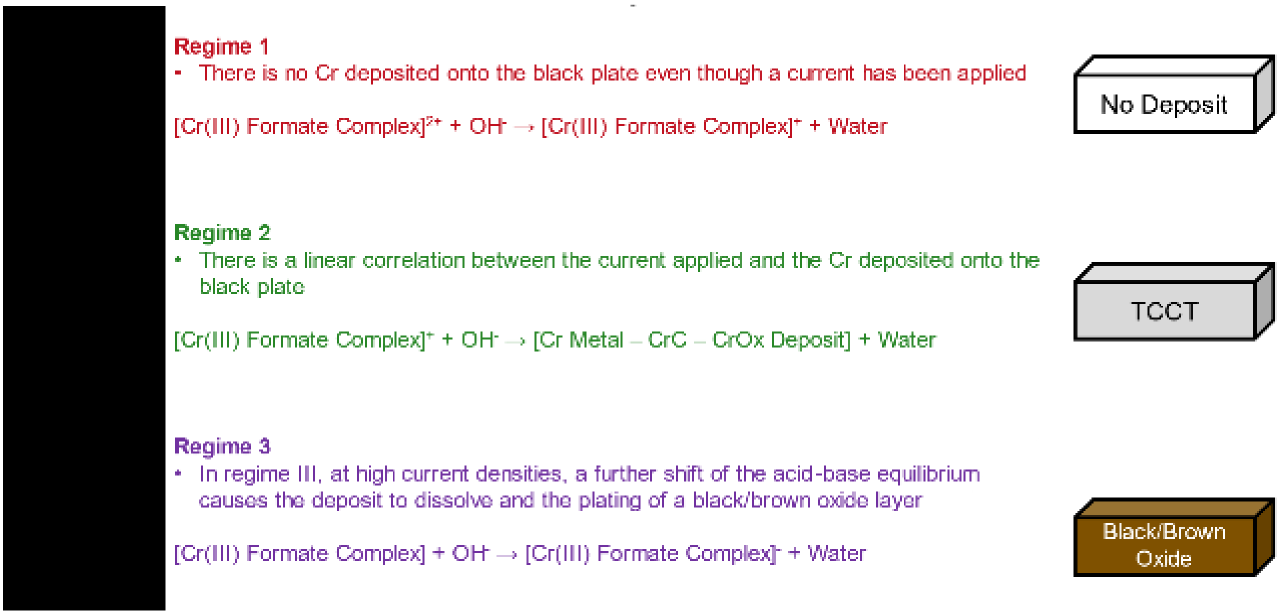

***Figure 30**: Chromium deposition results using a Cr(III)-formate electrolyte*

Further investigations were carried out on a laboratory scale using a rotating cylinder electrode to study the effects of varying parameters. These included changing pH, temperature, chromium concentration and sulphate concentration in both electrolytes. It was found that the amount of chromium deposited was strongly influenced by the applied current density, electrolysis time, temperature, pH and the chemical composition of the electrolyte.

- [redacted]
- [redacted]

The conclusion from this work was that further optimisation is required to determine the ideal set points for coating weight and surface appearance of the TCCT-coated substrate. The next steps include testing the corrosion performance of TCCT produced under optimised plating conditions, investigating the causes of appearance changes, potentially linked to the presence of various chromium complexes, and studying the effect of current density on the formation of pinholes. These pinholes, caused by hydrogen evolution at the steel surface, negatively affect both corrosion resistance and adhesion performance.

To date, 12 investigations covering 8 types of internal coatings on 8 different food contents and across 3 different sites have not yielded acceptable results. The following reports findings from some of these investigations as examples of the deficiencies identified. The key used in the test results is as follows:

(green)	Fully acceptable, equivalent to ECCS
(amber)	Not fully acceptable, but may potentially pass 4 year pack test
(red)	Not acceptable, unlikely to pass 4 year pack test

The following results were reported after 12 months by the applicant's largest customer ('Customer A') following pack testing of three different coatings at 20°C and 35°C and reveal significant corrosion issues.

	Chicken Soup	Split Peas	Tomato Soup
Ø73 EOE	Underfilm corrosion with rusting, blisters and lacquer lifting	Underfilm corrosion, microblisters and rust	Acceptable
	Underfilm corrosion and sulphide staining	Severe underfilm corrosion and microblistering*	Acceptable
	Underfilm corrosion, lacquer cracking and microblisters	Underfilm corrosion with microblisters, lacquer cracking and rust	Acceptable

	Chicken Soup	Split Peas	Tomato Soup
Ø65 EOE	Isolated underfilm corrosion with blisters	Underfilm corrosion, blisters and tin sulphide staining	Acceptable
	Underfilm corrosion with rusted microblisters and lacquer lifting.	Underfilm corrosion with rust, lacquer lifting and iron sulphide formation	Acceptable

* *Control also failed, further investigation required*

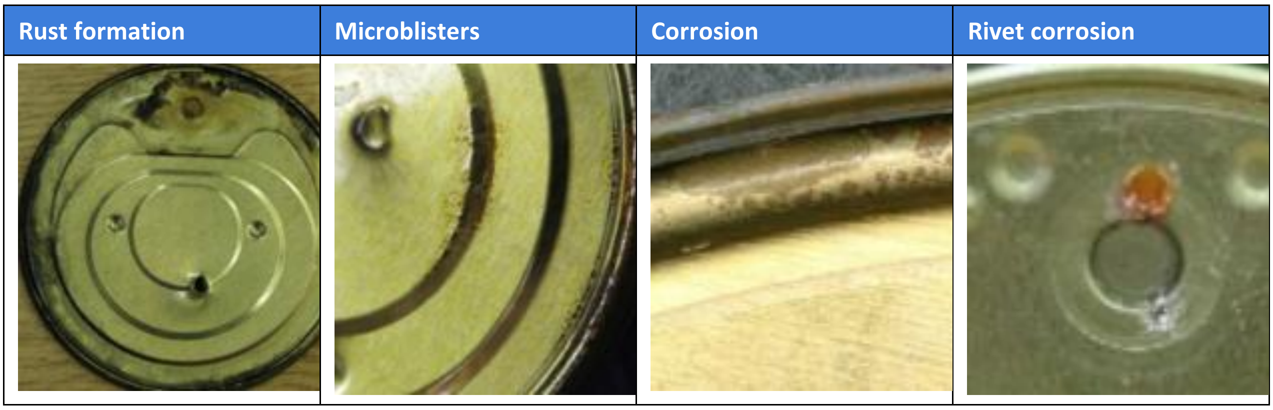

Figure 31*: TCCT test results reported after 12 months by Customer A following pack testing of three different coatings at 20°C and 35°C*

The following results were reported after 6 months by Customer A for fill pack testing of two different coatings at 35°C. The results for peas and carrots were better with the second filler; the root cause leading to the different results is still to be confirmed.

PEAS & CARROTS		GREEN BEANS
Filler A	Filler B	Filler B
6 months @35°C	6 months @35°C	6 months @35°C
Blistering at bead and rivet	Acceptable	Acceptable
Corrosion at bead	Acceptable	Acceptable

Figure 32*: TCCT test results reported after 6 months by Customer A for fill pack testing of two different coatings at 35°C*

The following results were reported after 3 months by Customer A's own customer's fill pack testing at 35°C involving pet food, which again failed due to corrosion issues.

PETFOOD
3 months @35°C
Frequent patches of underfilm corrosion, microblisters and loss of lacquer.

Figure 33*: TCCT test results reported after 3 months by Customer A's own customer for fill pack testing*

The following results were reported after 6 months by Customer A (this time at a different plant) for pack testing of four different coatings at 20°C and 35°C. Organosol coatings performed better than polyester phenolic coatings for the tuna in brine product.

Chicken Soup	Split Peas	Tomato Soup
Underfilm corrosion with rust, lacquer lifting and microblisters	Underfilm corrosion, rust and blisters.	Isolated corrosion

Roasted Peppers (Upright)	Roasted Peppers (Inverted)
Isolated corrosion	Isolated underfilm corrosion with rust at countersink

Tuna in Brine
Medium to heavy product staining. Iron sulphide formation.
Light product staining

Figure 34*: TCCT test results reported after 6 months by Customer A for pack testing of four different coatings at 20°C and 35°C*

Customer A will continue to share their experiences and milestones with TCCT. Their next critical review was scheduled for July 2025, when the 48-month performance results of material produced in 2021 will be assessed, although this material was not produced using the most recent TCCT configuration. The 36-month results for the 2022 material, which was produced using the updated process configuration, are expected around February 2026. The corresponding 48-month results will follow approximately in February 2027.

However, TCCT is demonstrably not delivering the same performance level as ECCS. So far, pack test results have only been acceptable for a limited range of applications, such as two-pass non-easy open ends and tuna cans, while most other applications have shown only marginal performance. At this stage, it is not possible to plan a scale-up for a broader range of applications. The worst-performing packs have been associated with a variety of coating systems, particularly easy open ends and single-pass non-easy open ends. The most problematic packs have predominantly contained products such as chicken soup and split peas. New pack trials will be necessary, incorporating improved lacquers and, ideally, an enhanced substrate. Coating suppliers have generally reported similar findings to those observed by Customer A, the applicant's largest customer.

At their current stage of development, Cr(III)-based alternatives do not meet the applicant's key functionality requirements:

- **Corrosion resistance**: [redacted] This key functionality is therefore not met.

- **Organic coating adhesion**: [redacted] As demonstrated by recent pack testing, significant issues remain with adhesion, resulting in many instances of lifting of the lacquer.

- **Chemical resistance** to the contents of the packaging: The stability and long-term performance of TCCT is significantly influenced by its contents. For food applications, certain foods present a more aggressive environment for metal packaging and can accelerate the degradation of protective coatings if the coating system is not sufficiently robust. This leads to issues such as underfilm corrosion, blistering or delamination of the organic coating, as revealed in recent pack tests. Less aggressive foods, e.g. those with neutral or slightly alkaline pH, may pose a lower risk to the integrity of the coating. In these cases, TCCT-coated substrates may perform adequately, maintaining adhesion and preventing corrosion over the product's shelf life. However, even with less aggressive foods, the long-term stability of the coating is not yet proven and must still be validated through pack testing, which is ongoing.

- **Compatibility with downstream processes**: As for other metal packaging, Cr(III)-based alternatives are expected to be capable of withstanding sterilisation and formation conditions. The same downstream processes for ECCS should therefore be possible with TCCT.

- **Suitability for food contact**: Coatings deposited through Cr(III)-based electroplating should be capable of meeting UK and EU food contact regulatory requirements, including both plain packaging and organic-coated packaging, as well as FDA food contact requirements. This is because the final surface layer produced by Cr(III)-based alternatives contains the same chemical components as those found in Cr(VI)-based processes, namely, metallic chromium (Cr(0)) and chromium oxide (Cr_2O_3).

- **Visual properties**: An advantage of Cr(III)-based alternatives over other potential alternatives is that the visual properties of the final product retain the typical chromium appearance, which may make it more readily accepted by both customers and consumers. However, the chromium oxide (Cr_2O_3) present in the Cr/ Cr_2O_3 layer tends to have a darker colour (samples with higher oxide content have exhibited a dark brown or blue hue). Additionally, contaminants in the process can influence the visual appearance. For example, the presence of water can cause a stripy effect on the chromium layer. Since the optical properties of packaging steels are critical for creating an attractive aesthetic, particularly in applications such as aerosol cans, these visual inconsistencies could be considered a drawback of the Cr(III) alternative for certain end uses.

- **Scalability and stability** of the production process: From a process engineering perspective, electrolytic deposition of Cr(III) is more sensitive to bath composition, pH, temperature and current density than Cr(VI) processes. Maintaining tight control over these parameters is essential to ensure coating uniformity and reproducibility. This makes scaling up from pilot to industrial scale more challenging and costly.

- **Sustainability**: In terms of recyclability, Cr(III)-based alternatives such as TCCT are considered to be as recyclable as ECCS. Both materials are steel-based and can be processed through standard steel recycling streams. The surface coatings, whether derived from hexavalent or trivalent chromium, are present in very small quantities relative to the steel substrate and typically do not interfere with the recycling process.

The following chart gives an overview of the technical feasibility of Cr(III)-based alternatives as an alternative to chromium trioxide for the production of ECCS.

Corrosion resistance	Organic coating adhesion	Chemical resistance	Compatibility with downstream processing	Suitability for food contact	Visual properties	Scalability and stability	Sustainability

Key:

	Not sufficient – the parameters / assessment criteria do not fulfil the requirements at the alternative's current stage of development.
	The parameters/assessment criteria fulfilment are not yet clear / the process is still not defined / further experimental investigations need to be performed.
	Sufficient - the parameters/assessment criteria do fulfil the requirements.

3.3.4 Economic feasibility

As described in the previous section, the TCCT alternative still presents significant technical challenges. It is estimated that an additional [redacted] million in R&D expenditure will be required to address these issues, on top of the [redacted] million already invested. In addition, scrap material losses (resulting from test products that could not be sold) are expected to total [redacted] million, in addition to the [redacted] million already incurred. Despite this investment, the outcome of the development process remains uncertain.

Nevertheless, assuming that acceptable technical performance can eventually be achieved, Tata Steel has committed to a programme of capital investment to adapt its operations both in IJmuiden and Trostre for the implementation of TCCT technology. In 2014, [redacted] million was spent on the pilot line in IJmuiden, followed by [redacted] million in 2016 for the main conversion of the IJmuiden facility. A further [redacted] million was spent on development of the two-step process, including a dryer and iron removal system.

At Trostre, [redacted] million has already been spent on conversion efforts. Initially, it was proposed to convert the ECCS line (ETL4) to TCCT entirely but due to issues subsequently encountered with TCCT technology following its industrialisation at IJmuiden and ongoing market demand for ECCS, converting ECCS4 is no longer viable. Substantial further investment is therefore necessary to enable Trostre to produce TCCT. In 2021, an entirely new TCCT line was scoped for Trostre at a cost of around [redacted] (public range: > £100 million) and which are itemised in the table below. Please note that these costs have not been adjusted for inflation and are expected to be considerably higher now.

[redacted]

[redacted]

***Table 13**: Costs associated with implementing a new TCCT line at Trostre*

The applicant has already committed to the above costs (assuming a Cr(III)-based alternative proves technically feasible) and so, from this perspective, the alternative can be viewed as economically feasible. However, any Cr(III)-based alternative simply aims to match the performance levels of the existing Cr(VI)-based technology. As such, no financial benefits are expected to be derived from the new product itself. This means that the net cost to Tata Steel for switching to TCCT will be significantly positive.

In addition, there would be significant economic impacts for customers, i.e. downstream users of the applicant's products. ECCS is a critical material for the metal packaging they manufacture, as it uniquely combines a durable substrate with strong adhesion for protective coatings and resistance to attack by food products, particularly those containing sulphurous compounds. Some of the applicant's customers have been testing alternatives to ECCS for several years and have reported that the materials currently offered by European steel mills do not match ECCS in either durability or chemical resistance. This is especially important for can ends, both 'classic' and 'easy-open', which are used across all food can applications.

If forced to move away from ECCS, customers have informed the applicant that they would anticipate several negative impacts, the most significant being the need for additional coating on both the internal and external surfaces of can ends. For example, one customer has stated that the consequences for them alone would include an estimated [redacted] million per year increase in coating costs due to the need for more and thicker layers to replicate ECCS's protective performance, an estimated [redacted] million investment in additional installed coating capacity, and an increase in greenhouse gas emissions resulting from the additional coating passes required. The applicant expects these impacts would be typical across its customer base.

Other potential implications, which are still being assessed, include the need to reduce output on customer filling lines, particularly if ECCS were replaced by tinplate, as seaming speeds would likely need to be reduced to prevent coating damage. There is also concern that some products, such as rhubarb and certain fish products, may no longer be suitable for canning. Additionally, higher levels of spoilage could occur due to increased customer complaints and returns. ECCS ends currently eliminate issues such as iron sulphide staining, which poses a high risk of complaints in many vegetable, meat, fish and pet food applications.

As chromium trioxide is only subject to authorisation in the UK and EU, steel producers in other regions, particularly in Asia, will continue to manufacture ECCS and supply both local and global markets. If ECCS were no longer available, this would create a strong risk of market shift toward imported steel, components and filled cans, with the impact likely to be felt across the entire supply chain, including raw material suppliers, packaging manufacturers, fillers and food producers.

3.3.5 Risk reduction

Alternative Cr(III)-based processes will involve compounds such as chromium hydroxide sulphate (chromium (III) sulphate, which is used in the TCCT process) or chromium trichloride (chromium (III) chloride). Both are classified as hazardous under CLP although for far fewer hazards than chromium trioxide. In particular, neither substance is classified for carcinogenicity and mutagenicity. In this way, the move from chromium trioxide to a trivalent chromium alternative can be seen as a move to less hazardous substances.

Conversely, both chromium (III) chloride and chromium (III) sulphate are classified for skin sensitisation category 1 by REACH registrants of the substance (among other hazards). A substance evaluation published on the ECHA website in 2022 for chromium (III) oxide[12] noted that a group assessment is currently under development by the evaluating Member State Competent Authorities under EU REACH for chromium (III) compounds more generally, due to concerns for skin sensitisation. The substance evaluation also identified a data gap for reproductive toxicity and suggested this can be addressed in a grouping approach, recommending that ECHA request further testing (an extended one-generation reproductive toxicity study and a developmental toxicity study).

Recent research has indicated that there is potential for Cr(VI) generation during the Cr(III) plating process.[13] This occurs because trivalent chromium may be oxidized by hydrogen peroxide, either generated through oxygen reduction or deliberately added to the coating environment, forming hexavalent chromium. The fluorides commonly present in the bath, which are used to accelerate film growth and dissolve native oxides, are thought to promote hydrogen peroxide formation, thereby facilitating the oxidation of Cr(III) to Cr(VI). Compounding this concern is the current lack of a recognised and validated analytical method to reliably detect and quantify Cr(VI) produced by trivalent chromium processes. This leaves uncertainty and complicates efforts to demonstrate a clear risk reduction compared to hexavalent chromium-based processes.

The manufacturing process for chromium (III) salts most commonly originates from chromite. To obtain the chromium from this mineral, the most widely used method involves an alkaline process which transforms the Cr(III) into water-soluble Cr(VI) in alkaline solution which is then separated.[14] Cr(III) salts can then be prepared by the reduction of sodium dichromate with sulphur dioxide. For chromium (III) sulphate, this reaction can be represented as follows:

$$Na_2Cr_2O_7 + 3\ SO_2 + H_2O \rightarrow Cr_2(SO_4)_3 + 2\ NaOH$$

Here, sodium dichromate would be used as an intermediate and so would not be subject to authorisation under REACH, with the increased focus on risk management measures this gives rise to (although it is possible that it might be handled under strictly controlled conditions if registered as an intermediate). This means that an increased demand for Cr(III) alternatives might result in risk reduction for the users (such as the applicant) but would result in increased health risks elsewhere in the supply chain, although it is acknowledged that this is likely to occur outside the UK.

Use of Cr(III)-based processes would also likely involve use of boric acid at significant concentrations as part of the bath chemistry (as a buffering agent). Boric acid is classified under CLP as toxic to reproduction category 1B and is itself identified as a SVHC under REACH. It was recommended for inclusion in Annex XIV of EU REACH in the sixth recommendation round although no equivalent regulatory action currently appears to be proposed under UK REACH. Its introduction (as part of implementing a trivalent chromium alternative) would not contribute to overall risk reduction. An alternative to boric acid would need to be identified if Cr(III) plating was used.

In summary, while it would appear at present that substitution of Cr(VI)-based electroplating processes with Cr(III)-based electroplating processes would, on balance, lead to an overall reduction in risk, the reduction is not necessarily as significant as may be first thought. In addition, it is based on existing

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

[13] Gharbi et al, 2018.

[14] Zang et al, 2016.

knowledge and further investigation through substance evaluation may identify additional concerns surrounding reproductive toxicity and skin sensitisation. Additionally, if substitution were to reduce risks in one part of the supply chain, it would drive them up in another, which does not lead to an overall reduced risk across the supply chain (even if it does for that part of it that is regulated by REACH authorisation requirements in the UK).

3.3.6 Availability

The substances required for Cr(III)-based electroplating appear to be commercially available at quantities sufficient to meet the applicant's demand, so in this sense the alternative can be considered available.

There are currently seven registrants of chromium (III) sulphate under EU REACH, registered in the 100-1,000 tonnes per year tonnage band. Chromium (III) sulphate also appears on the UK REACH grandfathered registrations notified substances list, although this list contains no information about applicable tonnage bands. Consequently, a dossier update may be required before the substance can be placed on the UK market in quantities sufficient for the applicant's needs.

3.3.7 Conclusions

Cr(III)-based alternatives are currently the most promising alternatives to Cr(VI)-based electroplating, although even after many years of development they still fail to meet required performance standards. This AoA has considered TCCT in particular, as an example of a trivalent chromium alternative. This alternative has been successfully qualified and is in use in Tata Steel's Ijmuiden plant in the Netherlands, but only for Protact products for one specific application (aerosols) for one main customer. Protact-laminated packaging steel comprises approximately 10% of Trostre's annual ECCS output only. The TCCT technology is therefore not sufficiently advanced to represent a technically feasible alternative across the vast majority of Trostre's ECCS business.

There are many factors influencing the performance of TCCT, likely as a result of the challenges associated with process stability, and significantly more R&D is necessary because the process is not yet fully understood. Maintaining process stability on an industrial scale with TCCT and other Cr(III)-based alternatives is particularly challenging. These challenges stem from both the chemical nature of Cr(III) and the technical demands of high-throughput, high-precision coating lines used in the production of packaging steel.

One of the primary difficulties lies in the chemical behaviour of Cr(III) compared to Cr(VI). Chromium trioxide (Cr(VI)) forms a highly reactive and self-healing oxide layer that provides excellent corrosion resistance and strong adhesion for organic coatings. In contrast, Cr(III) compounds are less reactive and do not form a uniform oxide layer. As a result, the oxide layer has to be created artificially. This makes it harder to achieve consistent coating quality, especially when trying to replicate the performance of mature Cr(VI)-based systems like ECCS. In particular, the adhesion of organic lacquers to TCCT substrates is highly dependent on the precise amount and uniformity of chromium oxide deposited. Achieving suitable adhesion of organic coatings therefore becomes particularly problematic.

Another issue is surface chemistry variability. TCCT coatings can exhibit chemical inhomogeneities across the width of the steel strip, which again affects the number of hydroxyl bonding sites available for lacquer adhesion. This variability can lead to inconsistent product performance, especially under demanding conditions like sterilisation or long-term storage with acidic foods.

From a process engineering perspective, electrolytic deposition of Cr(III) is more sensitive to bath composition, pH, temperature, and current density than Cr(VI) processes. Maintaining tight control over these parameters is essential to ensure coating uniformity and reproducibility. This makes scaling up from pilot to industrial scale more complex and costly.

If an alternative to chromium trioxide results in inferior performance, such as increased corrosion, lacquer delamination or staining, this can have significant consequences for customers and end users, particularly consumers of food and drink products packaged in ECCS. These defects compromise the protective barrier between the metal substrate and the food or beverage, potentially leading to contamination, spoilage or even foodborne illness. Corrosion, for instance, can result in the migration of metal ions into the food product, which may pose health risks depending on the nature and concentration of the metals involved. It can also affect the taste, appearance and safety of the food, leading to consumer dissatisfaction and potential product recalls. Lifting of the lacquer or staining may not only be aesthetically unappealing but also signal a breakdown in the integrity of the packaging, undermining consumer trust in the brand and the safety of the product.

From a regulatory perspective, such failures could lead to non-compliance with food contact material legislation, which requires that materials in contact with food must not transfer their constituents in quantities that could endanger human health or bring about an unacceptable change in the composition or organoleptic characteristics of the food. Moreover, these issues can have broader economic and reputational impacts, for instance, manufacturers may face increased costs due to product recalls, liability claims and loss of market share.

In summary, Cr(III)-based technology is not yet technically feasible as a suitable alternative for ECCS across all applications, particularly given the wide variety of materials (especially food products) that the applicant's customers will package using steel. While TCCT has been industrialised at Tata Steel's Ijmuiden site, this has only been for a specific application for one main customer. The applicant cannot afford to restrict their business to such a narrow scope. Their customers expect them to deliver products suitable for the full spectrum of applications and markets. If the applicant is no longer able to supply such products, their customers will be forced to seek ECCS alternatives elsewhere. These are readily available from international sources, including EU-based producers with an authorisation for the use of chromium trioxide (and, in the future, who may be compliant with any REACH restrictions on Cr(VI)), or non-EU suppliers, for example, the new ECCS facility currently under construction in Turkey.

Nevertheless, the applicant has already committed to a programme of capital investment to adapt its operations in Trostre for the implementation of TCCT technology in the hope that its performance deficiencies can be overcome. An entirely new TCCT line has been scoped at a cost of over [redacted] (public range: > £100 million), although cannot yet be given commercial approval until the Cr(III)-based process can meet key functionality requirements. However, the long-term success of this alternative is far from guaranteed.

4. Substitution Plan

4.1 Summary of substitution activities

The applicant's initial AfA aimed to be a bridging authorisation, in that a promising potential alternative (TCCT) had been identified but more time was needed before it could be implemented. At the time, the applicant was covered by the CTACSub AfA led by Chemservice and did not believe the substitution plan could be completed before the anticipated end of any granted authorisation.[15] Accordingly, the applicant decided to prepare their own downstream user AfA, containing a substitution plan that aimed to have completed a move to the alternative during 2026.

However, since the initial AfA was made in April 2019, substitution efforts have not proceeded as originally anticipated. In October 2021, Tata Steel formally split its European operations into two separate entities: Tata Steel UK (the applicant) and Tata Steel Netherlands ('TSN'). The split resulted in the end of the operational Tata Steel Europe organisation, with the two new companies operating independently. As a result of this split, the applicant lost access to Tata Steel Packaging's R&D facilities located at TSN (the IJmuiden Technology Centre or IJTC) which was leading on the development of Cr(VI) alternatives.

Without its own equivalent R&D facilities for packaging in the UK, the applicant therefore became reliant upon TSN being able to successfully complete the development of TCCT, after which it could deploy the same process in the UK by purchasing the licence for the technology from TSN. To this end, the applicant has already developed a capital investment proposal to replace its ECCS production at the Trostre Works with TCCT, estimated at over [redacted] (public range: > £100 million) (see section 3.3.4 above).

However, TCCT has not proven to be a suitable alternative for most Cr(VI)-based products. Since 2019, it has been qualified for production of Tata Steel's 'Protact' products, a three-layer polymer-coated steel product, albeit for one specific application and one main customer only. For non-Protact products, significant concerns remain over its technical feasibility, explored in further detail in section 3.3.3 above. The Cr(III)-based technology is notoriously challenging, not yet fully established at scale and has not successfully passed pack testing. Resulting products do not exhibit all the beneficial attributes of ECCS produced with Cr(VI).

The applicant produces Protact products at the Trostre Works, albeit using a Cr(VI)-based process, not the TCCT process. However, Protact only accounts for around 10% of ECCS production at Trostre [redacted]. It is therefore not economically feasible to replace existing ECCS production (based on Cr(VI) technology) with TCCT (based on Cr(III) technology) because the applicant would then lose the vast majority of its current ECCS product range, for which TCCT is not a technically feasible alternative.

The applicant remains reliant on TSN's further development of Cr(III)-based alternatives through the IJTC. However, the pace of R&D has slowed significantly, for two main reasons:

- [redacted] As a result, it has less commercial interest in developing TCCT as a replacement for all ECCS products that the applicant currently produces.

- Secondly, the European Commission has recently requested that ECHA prepare a restriction proposal for Cr(VI) substances under EU REACH that would transfer their regulation from Annex XIV

[15] The applicant's original AfA was submitted before the European Court of Justice (ECJ) annulled the European Commission's decision to grant authorisation for 4 of the 5 uses of chromium trioxide which had received a positive decision in the CTACSub AfA. The ECJ decision was made in April 2023 and the annulment came into effect from 20 April 2024, since when the AfA has reverted to 'decision pending' status. However, following the UK's exit from the EU and the transitional provisions for authorisation under UK REACH, the applicant is no longer covered by the CTACSub AfA which ceased to have effect under UK REACH in September 2024 (the original date of expiry of the granted authorisations).

(authorisation) to Annex XVII (restriction). When the restriction enters into force, the use of chromium trioxide in the EU will be able to continue without authorisation, provided the conditions of restriction are met. Details of the restriction proposal were published in May 2025 and would only permit the continued use of Cr(VI) substances for certain well-defined uses and providing strict worker exposure and environmental emissions limits are met. Electroplating using chromium trioxide is one of the defined uses and businesses in the EU that have implemented good control practice should be able to meet the mandated limits. If so, those businesses will be able to continue to use Cr(VI) substances, meaning there will be much less emphasis on substitution.

Given these circumstances, the applicant has been forced back to a much earlier stage in their substitution efforts and without the R&D capability from which they previously benefited when part of the wider Tata Steel Europe organisation. For instance, the applicant has no research laboratories or pilot lines for packaging R&D in the UK.

The applicant remains committed to looking for alternatives to the use of chromium trioxide and has already invested considerable resource into these efforts, with further investment planned. Further details on the applicant's efforts and resources committed to substitution are provided in sections 3.2.1 and 3.3.4 above. Efforts currently focus on development of Cr(III)-based alternatives in the hope that the current performance deficiencies can be overcome.

However, the applicant currently has no 'drop-in' alternative to chromium trioxide-based electroplating that fulfils all key functionalities. Further time is therefore required in order to continue R&D efforts in an attempt to resolve the technical challenges associated with Cr(III)-based alternatives and, assuming they can be overcome, then qualify and transition to that alternative on the industrial scale. Further R&D activities, scale-up, industrialisation and transition are major factors in the timescales required.

A granted authorisation will allow the applicant to continue its existing activities to transition to a suitable alternative. Such substitution activities are described in detail in the substitution plan below, along with associated timescales, complexities and uncertainties.

4.2 Conclusion on suitability of available alternatives in general

Following the judgment of the General Court in the lead chromates pigments case,[16] businesses applying for authorisation for the continued use of a substance where there is a suitable alternative generally available (SAGA) are expected to submit a substitution plan.[17]

The lead chromates pigments case involved the General Court of the European Union annulling a Commission decision granting an authorisation for certain uses of two lead chromate pigments. As regards the assessment of the suitability of alternatives under Article 60(4) of REACH, the Court found that if suitable alternatives are available in general, albeit not technically or economically feasible for the applicant, and if the applicant demonstrates that the socio-economic benefits of continued use outweigh the risk to human health and the environment, an authorisation may be granted if the applicant submits a substitution plan.

[16] EU General Court judgment of 7 March 2019 in Case T-837/16, *Sweden v. Commission*, upheld on appeal in the EU European Court of Justice judgment of 25 February 2021 in Case C-389/19 P, *Commission v. Sweden.*

[17] Despite the UK having since left the EU, the European Union (Withdrawal) Act 2018 provides that relevant cases of the Court of Justice of the European Union (CJEU) formed part of retained EU law in the UK (now referred to as 'assimilated' law). This meant that UK courts and tribunals still had to follow pre-exit CJEU case law, unless the Supreme Court decided to depart from it or retained EU law itself is modified. The Retained EU Law (Revocation and Reform) Act 2023 then stipulated that the Court of Appeal and the Supreme Court were no longer bound by assimilated case law except where domestic case law has already modified or applied it. Even so, lower courts must still follow assimilated case law and more senior courts will no doubt continue to find it persuasive.

Based on the applicant's analysis, the current Cr(III) technology is not a SAGA. This, and all other alternative technologies and processes considered in the AoA, currently fail because they are not technically and economically feasible. Cr(III) electroplating technology does exist and in one sense could be adopted by any manufacturer – in this sense, it is 'generally available'. However, the applicant is unable to use it for their own purposes due to its clear technical deficiencies compared with the existing Cr(VI)-based process.

Therefore, for the applicant's product range, their analysis has not identified any SAGA. Nevertheless, the applicant respects and agrees with the objectives of REACH authorisation to substitute very hazardous substances to less hazardous alternatives. For this reason, even though a substitution plan is not legally required under REACH, the applicant has still produced (and is in the process of implementing) a substitution plan. This is described below and submitted as part of this application to signal the applicant's commitment and intention to identify and implement an alternative to chromium trioxide for the manufacture of ECCS.

4.3 Substitution Plan

4.3.1 Factors affecting substitution

The substitution process is shaped by two main factors: the development of a suitable Cr(III)-based process by the applicant and then its introduction to customers. Each area involves a set of critical factors that influence the overall timeline and success of the transition.

- In terms of process development, key factors include identifying and resolving the root causes of defects in products made using a Cr(III) alternative, finalising the design and operation of the Cr(III) process itself, and then constructing a new Cr(III) production line at Trostre. The applicant has lost access to Tata Steel Packaging's R&D facilities at IJmuiden, including a pilot line, and has no equivalent facilities in the UK. The applicant would therefore need to partner with a University to progress substitution efforts.

- On the customer side, the introduction of a Cr(III) alternative involves them evaluating and then accepting the new products against the continued use of imported ECCS. This includes completing rigorous testing and qualification procedures, including long-term packaging trials for food applications. Customers may also need to commit to capital expenditure for modifying existing production lines, currently based on ECCS, e.g. upgrading tooling or lacquering equipment. The availability of technical and operational resources, both at the applicant's and customer facilities, will also be needed to ease the transition.

There are several areas of uncertainty that could impact the substitution plan. First, there are ongoing concerns about defects in the Cr(III) process, which could stem from either design limitations or more fundamental issues related to the chemistry of the process. Second, introducing a new product based on Cr(III) electroplating (such as TCCT) into customer operations is inherently complex. These customers operate high-speed, high-volume industrial installations that may require significant adaptation to accommodate the new material. Third, the market response remains uncertain, particularly in terms of whether customers will accept the burden of transitioning to a new product or simply continue using ECCS by importing it from non-UK manufacturers.

Additionally, the applicant is aware that potential regulatory changes in the EU will significantly impact R&D commitments to Cr(VI) substitution. Moving chromium trioxide and other Cr(VI) substances from Annex XIV of EU REACH to Annex XVII of EU REACH removes the requirement to phase out the use of these substances. As a result, it is expected that R&D planning and budgets in the EU will be reviewed. The UK steel market is closely aligned to the EU market. This means investment in alternatives needs to be very carefully planned to ensure an acceptable return on investment can be realised in a reasonable timeframe and that investment is focused on the greatest opportunities to secure a safe and sustainable future, aligned to multiple completing goals such as net zero and safer products and processes. On this basis, the applicant will regularly and carefully review progress towards substitution relative to factors including regulatory pressures, customer requirements and market opportunities.

The implementation of a Cr(VI)-free alternative will be carried out in several phases, each of which carries specific risks tied to the uncertainties mentioned above which could delay substitution timelines:

- **Development of the Cr(III)-based process**: As previously discussed, Cr(III)-based processes still present notable deficiencies. These may be due to the current design setup or to more fundamental issues with the chemistry and process. While it is assumed that these problems can be resolved through changes to the chemistry, process parameters or design changes, this introduces significant uncertainty into the timeline for full implementation.

- **Installation and commissioning of a new Cr(III)-based production line**: An entirely new production line would be required at Trostre, because Cr(III)-based products cannot be manufactured alongside ECCS products on the existing ETL4 line. This is a large-scale, and costly, industrial project and, as such, it carries the typical risks associated with construction and operational start-up.

- **Successful packaging trials**: Accelerated tests cannot accurately predict the behaviour of the product during consumer use conditions. Some of the critical factors affecting packaging performance, such as chemical interactions between the packaging and its contents, develop slowly and may only become apparent late in the testing process. This means that deficiencies could emerge even at the final stages of these trials.

- **Successful introduction of the Cr(III)-based products to the market**: The customer conversion phase introduces its own set of risks. During this phase, customers will need to determine whether process and equipment modifications at their own facilities will be needed and, if so, whether it is more cost efficient to continue using ECCS by purchasing it from abroad. If customers do switch to the new products, this could subsequently reveal issues not previously identified, e.g. based on the interaction between the chromium-plated steel and the organic coating. It would also see the applicant become a competitor of Tata Steel Netherlands whose IJmuiden plant already produces a Protact product from Cr(III)-based TCCT. It is assumed that any breakthrough in TCCT technology enabling it to be deployed for non-Protact applications would originate from, or be subsequently implemented by, Tata Steel Netherlands, which could stunt the applicant's market growth.

4.3.2 List of actions and timetable with milestones

A substitution plan was included in the applicant's initial AfA that aimed for successful transition to a Cr(III)-based process (TCCT) by 2026 at Trostre. However, work had begun on a Cr(III) alternative back in 2007 where Tata Steel Packaging's R&D facility (the IJTC) at Ijmuiden started to investigate Cr(III)-based alternatives on the laboratory scale as well as the initiation of early-stage trials and validation efforts. This involved detailed investigation over many years to evaluate different chemical compositions, process variables and their interactions, as well as testing programmes to assess the performance of the Cr(III)-based electrolytes against key functional requirements. A pilot production line was also constructed to facilitate scaled-up trials to further investigate and refine process parameters in an attempt to optimise performance.

These efforts ultimately led to qualification of TCCT for a specific Protact application and its commercial production from 2020 for one main customer. However, by 2021 it had become clear that the initial industrial-scale version of TCCT was not suitable as a direct replacement for ECCS more generally. Persistent failures in pack tests have limited the broader adoption of TCCT. Indeed, to ensure continued supply to both customers and end consumers, ECCS is still used to support other Protact products manufactured by Tata Steel Netherlands and is used for all Protact products produced at Trostre. This means that, despite nearly 20 years' worth of effort, the applicant still has no suitable alternative to the use of chromium trioxide for the production of ECCS.

For the reasons discussed in section 4.1 above, the applicant finds themselves having to revert to an earlier stage of substitution planning and has prepared a revised substitution plan outlined in Table 14 below. The steps and timeline of this revised substitution plan are based on the applicant's experience with the development of TCCT at the IJmuiden site.

The substitution of Cr(VI)-based electroplating to a suitable alternative will be a lengthy process comprising numerous activities, with uncertainties associated with each and possible technical or other issues that may affect the actions or the timing of actions. Nevertheless, the applicant has prepared a timeline which comprises ten steps, from conducting R&D activities to the final introduction of the alternative. These phases are described in further detail in Table 14 (and depicted in Figure 35) with associated timescales, complexities and uncertainties.

Some of these timescales involve variable periods of time, e.g. where it is not certain how long a particular step might take or because of specific customer requirements in certain sectors. In order to achieve a suitable balance between 'best-case' and 'worst-case' scenarios, some degree of overlap is anticipated by the Substitution Plan. The substitution timelines therefore overlap where appropriate (see Figure 35). In addition, assumptions are used to shorten the duration of some phases, although this is not guaranteed. The plan therefore demonstrates that, even taking overlapping periods, uncertainties and assumptions into account, **there is good justification that a review period of at least 15 years is needed until substitution of chromium trioxide for the production of ECCS can be achieved** and, in reality, substitution may well take even longer than that.

Step	Timing	Description	Milestones	Uncertainties & challenges
Step 1 **Establish partnership** (Responsibility: Applicant)	2025 – 2026	Thie step involves approaching Universities with the opportunity to develop a new coating in partnership with the applicant. The applicant is no longer able to access Tata Steel Packaging's R&D centre at IJmuiden and so will require access to alternative specialised expertise, laboratories and analytical equipment which a University can provide. This step is assumed to take the remainder of 2025 to establish, as larger or more complex sponsored research agreements can take 3 to 6 months or more, especially if matters such as intellectual property or publication rights are heavily negotiated.	Agreement reached, e.g. sponsored or collaborative research agreement	Negotiations to reach an agreement may take longer than anticipated, e.g. due to issues over intellectual property, confidentiality vs publication rights funding etc. Programme likely to take the form of a doctorate which will last at least 4 years but may extend to 8 years.
Step 2 **Concept development** (Responsibility: University partner)	2026 – 2027	The concept development phase will begin by clearly defining the coating's intended use, including the types of metal packaging it will serve and the environmental conditions it must withstand. This ensures the project is aligned with real-world performance needs and regulatory requirements. Next, the essential properties of the coating will be identified. These include corrosion resistance, durability, adhesion, aesthetic qualities and food safety compliance. The coating must also be compatible with existing manufacturing processes and application methods. Market and regulatory research will be conducted to benchmark current Cr(VI)-free coatings and ensure compliance with REACH and food contact regulations. Input from customers and other stakeholders will help shape the direction of development. A review of previously considered alternatives will be expanded through literature and patent research to identify promising new technologies. Each will be assessed for feasibility, performance and regulatory acceptance. Preliminary technical specifications will then be drafted, outlining key parameters and functional requirements. These will guide the University partner's formulation and testing work. A high-level roadmap with milestones and resource planning will provide structure for the next stages of development.	Completion of a comprehensive report containing, for example, a clearly defined purpose and application scope, the required performance / technical requirements, a summary of market and regulatory research findings, draft preliminary technical specifications for the coating, and a proposed roadmap for formulation and testing phases	Much of the relevant information from literature and patent reviews may be proprietary, unpublished, lacking in detail or irrelevant to the applicant's market. The development of preliminary technical specifications can be hindered by the lack of experimental data. Aligning the expectations and requirements of various stakeholders may be problematic. Internal teams, e.g. production, quality and regulatory, may have differing priorities or constraints. Similarly, external partners, including the university research team, may require time to fully understand the industrial context and adapt their academic approach. Market research can also be a time-intensive process. Gathering meaningful insights may not yield immediate results.
Step 3 **Formulation development**	2027 – 2029	The next phase of the substitution plan focuses on formulation development, where the goal is to create a viable, Cr(VI)-free coating that meets the performance and regulatory requirements identified	The outcome of this step will be a working formulation supported by initial laboratory-	One of the primary risks is the unpredictable behaviour of raw materials when combined, which may interact in unexpected ways.

Step	Timing	Description	Milestones	Uncertainties & challenges
(Responsibility: University partner)		during concept development. This stage will begin with researching and selecting appropriate raw materials, e.g. resins, pigments, solvents, and additives, that can deliver the desired properties. The selection process will be guided by both technical performance criteria and regulatory considerations. Once suitable materials have been identified, a range of candidate formulations will be developed and tested under laboratory conditions. These initial trials will assess the feasibility of each formulation, focusing on key performance indicators such as adhesion, hardness and resistance to temperature or chemical exposure. Based on the results, the formulations will be refined through multiple iterations to optimise their performance. This iterative process is expected to span several cycles of testing and adjustment, with the number of iterations depending on the complexity of the performance targets and the behaviour of the materials involved. Given the experimental nature of this work and the need for thorough testing and refinement, this stage is expected to take up to three years. It will be conducted in parallel with the latter part of the concept development phase to ensure continuity and efficient use of time and resources.	scale performance data.	The iterative nature of formulation, where multiple rounds of testing and adjustment are required, can introduce delays, especially if early prototypes underperform or if testing reveals unforeseen weaknesses. Lab-scale results will often not translate directly to industrial-scale processes, requiring further adaptation and optimisation. Collaboration with a university partner may also introduce scheduling constraints due to academic calendars or resource availability.
Step 4 **Laboratory testing and optimisation** (Responsibility: University partner)	2028 – 2031	This step involves evaluating the performance of the newly-developed coating under controlled conditions. This will involve conducting a series of physical and chemical tests to assess key properties such as hardness, corrosion resistance and weatherability. These tests are essential to determine how well the coating performs in environments that simulate real-world conditions. Based on the results, the formulation will be adjusted to address any shortcomings and enhance its overall performance. This iterative process will ensure that the coating not only meets the technical requirements but also maintains consistency and reliability across different batches. This step will also explore the most effective application techniques. Methods such as spraying, dipping and brushing will be tested to determine which provides the best coverage, adhesion and finish on substrates.	The outcome of this step will be an optimised coating formulation, supported by robust/repeatable performance data, which is ready for further validation.	There may be significant variability in test results, especially when working with new or complex formulations that may behave inconsistently under different conditions. Reproducing results reliably across multiple tests is essential but can be time-consuming if early formulations show marginal or unstable performance. The optimisation process often requires multiple rounds of adjustment and re-testing, which can extend timelines, particularly if improvements are incremental or if changes to one property negatively affect another.

Step	Timing	Description	Milestones	Uncertainties & challenges
Step 5 **Prototype development and small-scale production** (Responsibility: University partner)	2031 – 2032	This step involves producing limited batches of the preferred coating formulation and applying it to real-world substrates to evaluate its performance. These small-scale batches will be used to create prototype samples, which will then be tested under conditions that closely simulate actual use. The goal is to assess how the coating behaves outside of laboratory settings, including its durability, appearance and consistency when applied using industrially relevant methods. During this phase, the application process may need to be adjusted to ensure uniformity and quality across different substrates and production runs.	The outcome of this step will be a validated prototype coating that can consistently meet the defined performance criteria and is ready for scale-up.	One key uncertainty is how the coating will perform when applied to real-world substrates using production-relevant methods, as lab-scale success does not always translate directly to practical application. Producing small batches at a consistent quality can be difficult without access to fully controlled manufacturing conditions, potentially leading to issues with reproducibility.
Step 6 **Scale-up and process development** (Responsibility: University partner and applicant)	2032 – 2033	This step focuses on transitioning from small-batch prototype production to larger-scale manufacturing. This will involve developing and testing pilot-scale production methods that can reliably produce the coating in greater quantities while maintaining the performance and quality demonstrated in earlier stages. During this phase, the production process will be carefully optimised to ensure consistency, efficiency and repeatability. A key part of this work is verifying that the coating is compatible with existing industrial equipment and processes, which may require adjustments to application techniques or curing conditions.	The outcome of this step will be the establishment of a robust, scalable production process that can meet commercial demand without compromising on quality or regulatory compliance.	This step assumes that the pilot line at the Tata Steel IJmuiden site will be available. If not, there may be a need to install a pilot line at Trostre, which could severely delay this stage and add considerable cost. Processes which work well at laboratory or pilot scale do not always translate smoothly to industrial-scale operations. Differences in equipment, processing conditions and material handling can introduce variability that affects coating quality, consistency or performance. This may force a return to an earlier stage of the substitution plan.
Step 7 **Customer testing and approvals** (Responsibility: Customers)	2034 – 2037	The customer testing and approvals stage is a critical phase in the substitution plan, as it involves validating and qualifying products produced with the new coating in real-world downstream manufacturing environments. During this stage, selected customers will trial the new product on their own production lines and, where relevant, overlaying it with organic coatings such as lacquers. These trials will assess how well the new product integrates into existing production processes, including the application and curing of coatings and the product's performance under operations such as forming, seaming and sterilisation.	The outcome of this step will be customer approval / qualification of the new product for various sectors (e.g. food and drink, aerosols, general line etc)	The customer testing and approvals stage is particularly vulnerable to delays due to its reliance on external parties and long pack testing timelines (up to 4 years) bearing in mind the strict regulatory requirements. In particular, early results may be inconclusive or failures may occur late in the testing cycle. One major uncertainty is the variability in how different customers implement and evaluate the coating within their own production environments, which can lead to

Step	Timing	Description	Milestones	Uncertainties & challenges
		In the food packaging sector, this stage also includes long-term packaging performance tests, commonly referred to as pack tests. These tests simulate the full lifecycle of a packaged product, including storage, transport and shelf life, and can take up to four years to complete depending on the product type and regulatory requirements. The objective is to confirm that the coating maintains its integrity, safety, and protective properties over time, particularly in contact with food. Customer approvals will depend not only on technical performance but also on compliance with food safety regulations and internal quality standards. This phase is essential for building customer confidence and securing commercial adoption, but it is inherently time-consuming and must be carefully managed to avoid delays in market entry.		inconsistent feedback or the need for tailored adjustments. Customer priorities or production schedules may shift, causing delays in trial execution or feedback. Any issues identified during these trials may require further adjustments to the formulation or application process to ensure seamless adoption. These factors make this stage one of the most unpredictable and time-intensive in the project, requiring proactive coordination and contingency planning to manage effectively.
Step 8 **Commercial and regulatory approvals** (Responsibility: Applicant)	2038 – 2039	This step of the substitution plan begins once the Cr(III)-based alternative has been successfully validated as a direct replacement for ECCS in both performance and application. With technical feasibility established, the focus shifts to securing the necessary commercial and regulatory approvals to move toward full industrialisation. A key part of this process involves preparing and submitting a capital expenditure (CAPEX) application. This application must be supported by a detailed volume and cost analysis to demonstrate the economic viability of the new process. Due diligence will be carried out to assess the production capacity of the alternative, including its impact on processing times, cost implications and the ability to meet key functional requirements. The goal is to ensure that the new process is not only technically sound but also commercially sustainable. In parallel, internal consultation with cross-functional teams, including safety, environmental, regulatory, process, technical and engineering experts, will be essential to ensure that the proposed production line meets operational expectations. This will involve conducting an initial Failure Modes and Effects Analysis (FMEA) and reviewing SAP systems to identify spare parts requirements and potential maintenance needs. Consideration must also be given to the impact on existing standards and certifications, described in section 2.5.4.4 of this report, and an environmental permit variation will be required. Planning permission may also be necessary, depending on the scale and nature of the	The outcome of this step will be securing commercial approval to proceed and ensuring the necessary regulatory compliance steps are met	The CAPEX application will need to satisfy internal financial scrutiny while accurately forecasting costs, volumes and return on investment. If the economic case is not compelling or if key assumptions are questioned, the approval process may be prolonged. The need to secure permit variations (and potentially planning permission) can extend timescales. Sourcing contractors and materials at the right cost and quality can be unpredictable. Delays in procurement or contract negotiations can disrupt the project timeline and increase costs. Preliminary investigation has suggested a current +18 month wait on certain specialised equipment required for a fully functioning line.

Step	Timing	Description	Milestones	Uncertainties & challenges
		modifications. Finally, sourcing the most suitable contractors, services and materials at competitive prices will be crucial to keeping the project on schedule and within budget. This comprehensive approach ensures that the transition to industrial-scale production is both compliant and commercially robust.		
Step 9 **Installation of production line** (Responsibility: Applicant)	2040 – 2042	The installation of a new production line will mark a major milestone in the substitution project and requires careful planning and execution. The process will need to begin with the removal of an existing, decommissioned line at Trostre, which must be managed in accordance with strict health, safety and environmental standards. These include the implementation of detailed risk assessments and work methods under permit to work involving specialist third party contractors. Environmental considerations are also critical at this stage, particularly in relation to the recycling or disposal of decommissioned equipment and materials. A thorough site survey will be conducted to prepare for the new installation, and regular scheduled meetings will be held to monitor progress against defined timescales, milestones and budget. Following the removal phase, the construction and installation of the new production line will be managed with the same level of rigour. As well as risk assessments and method statements for the build, new risk assessments, standard operating procedures and training will need to be devised and implemented for production when it commences. In parallel, quality assurance documentation will need to be updated in line with ISO 9001 requirements to reflect the new processes and equipment. Environmental management arrangements will also be revised, with changes to emissions monitoring for air and water implemented to ensure the new installation can operate within permitted limits.	This step will be complete once the new production line has been successfully installed and commissioned.	There is the potential for unforeseen site conditions during the removal of existing equipment or preparation of the installation area. Structural issues or contamination may require remediation or redesign, which can significantly impact the schedule. Delays can also arise from the coordination of multiple contractors and suppliers, particularly if there are issues with the availability of specialised equipment, long lead times for components, or disruptions in the supply chain. Equipment commissioned during building can behave differently when subjected to true line running condition. Experience suggests a stress tests of the line from multiple parameter variants and run times will undoubtedly raise a snagging list.
Step 10 **Transition of production to approved alternative process**	2042 – 2043	This final step involves the full transition from the Cr(VI)-based coating process to the approved Cr(III)-based alternative. New contracts will be entered into for supply of products that can be produced without the use of chromium trioxide, as customers begin to accept the alternative. However, existing contractual obligations will still need to be fulfilled involving Cr(VI)-based production.	This step can be considered complete when the logistics associated with production and inventory transition are complete and the Cr(VI) process has been fully decommissioned.	One of the primary challenges is ensuring that the new production line consistently meets specification at full scale, as even minor deviations in quality or performance could impact customer confidence or require further optimisation. For instance, experience

Step	Timing	Description	Milestones	Uncertainties & challenges
(Responsibility: Applicant)		There will need to be a controlled ramp-up of the new production line, gradually increasing output while phasing out the legacy ECCS products. During this transition, it is essential to confirm that the new line consistently produces material to the required specification, with ongoing technical support to optimise process parameters and resolve any early-stage production issues. Quality assurance protocols will be closely monitored to ensure that the new products meet all performance, regulatory and customer requirements. At the same time, efforts will focus on filling the customer supply chain with the new product, ensuring that downstream users receive sufficient volumes for their operations. This may involve working closely with customers to support their conversion to the new material, particularly where modifications to downstream tooling or production equipment are required. To safeguard existing supply commitments, a strategic back stock of ECCS may need to be built up in advance, allowing for a buffer during the transition period. Once the new product is fully integrated into the supply chain and customer approvals are secured, the ECCS production line can be safely decommissioned. This final step will include appropriate environmental and safety procedures in advance of any subsequent equipment removal and site restoration.		shows that the TCCT application process is highly reactive to any contaminants or parameter variability. Customer conversion also presents a risk, particularly if downstream equipment needs modification or if customers are slow to approve or adopt the new products. Managing inventory during the transition is complex, as it requires balancing the ramp-up of the new product with the phase-out of ECCS, while also maintaining contractual supply obligations. Any delays in building up back stock or unexpected demand fluctuations could strain supply chains.

***Table 14**: Substitution steps, timelines and uncertainties / challenges*

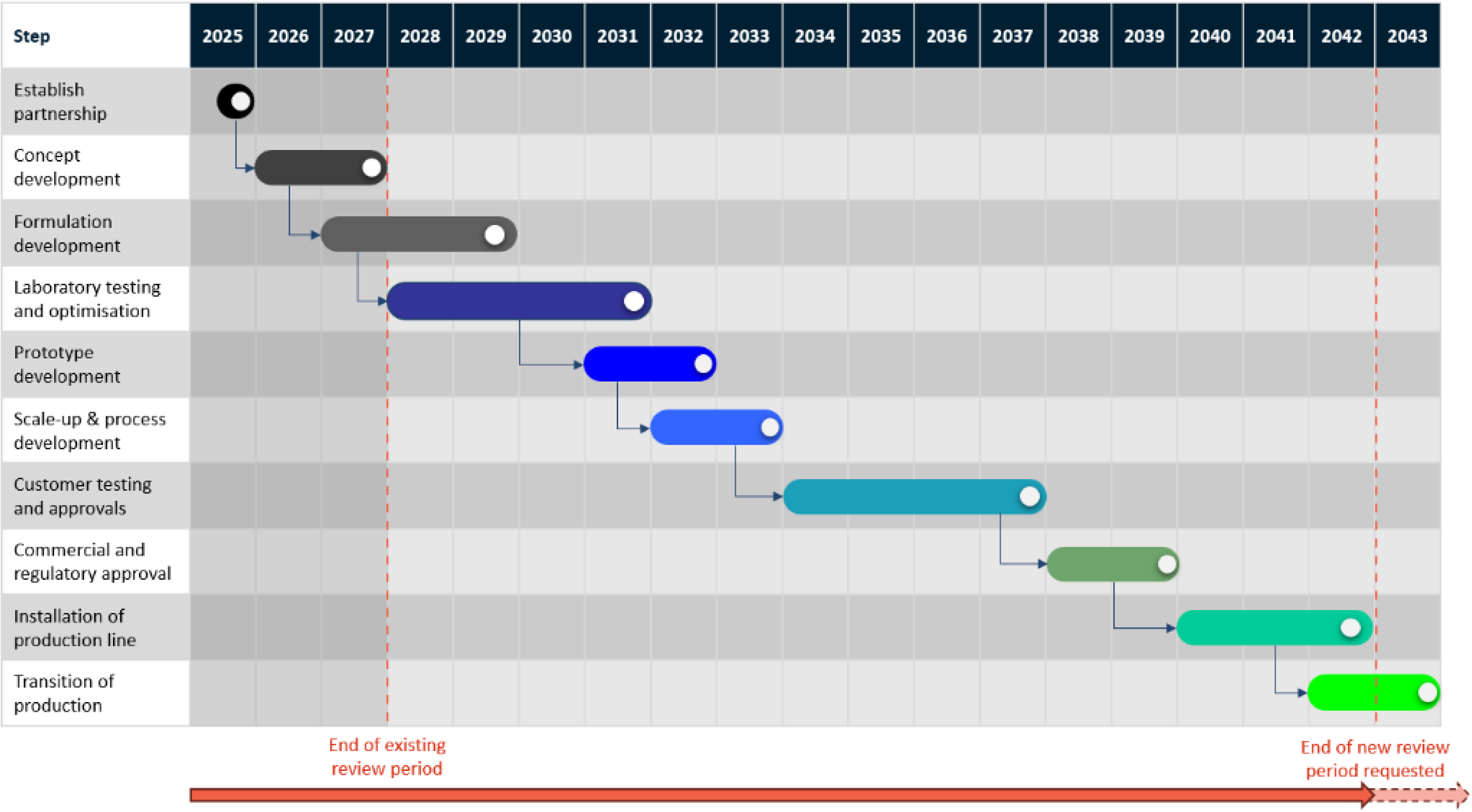

***Figure 35**: Substitution roadmap*

4.4 Monitoring implementation of the substitution plan

A project must pass through several phases before it can be implemented in any production facility. The applicant defines the following four phases in their Project Manual:

1. Concept
2. Definition
    - Development
    - Planning
3. Implementation
    - Design, Procure, Manufacture (DPM)
    - Construction
    - Commissioning
4. Handover and Closeout

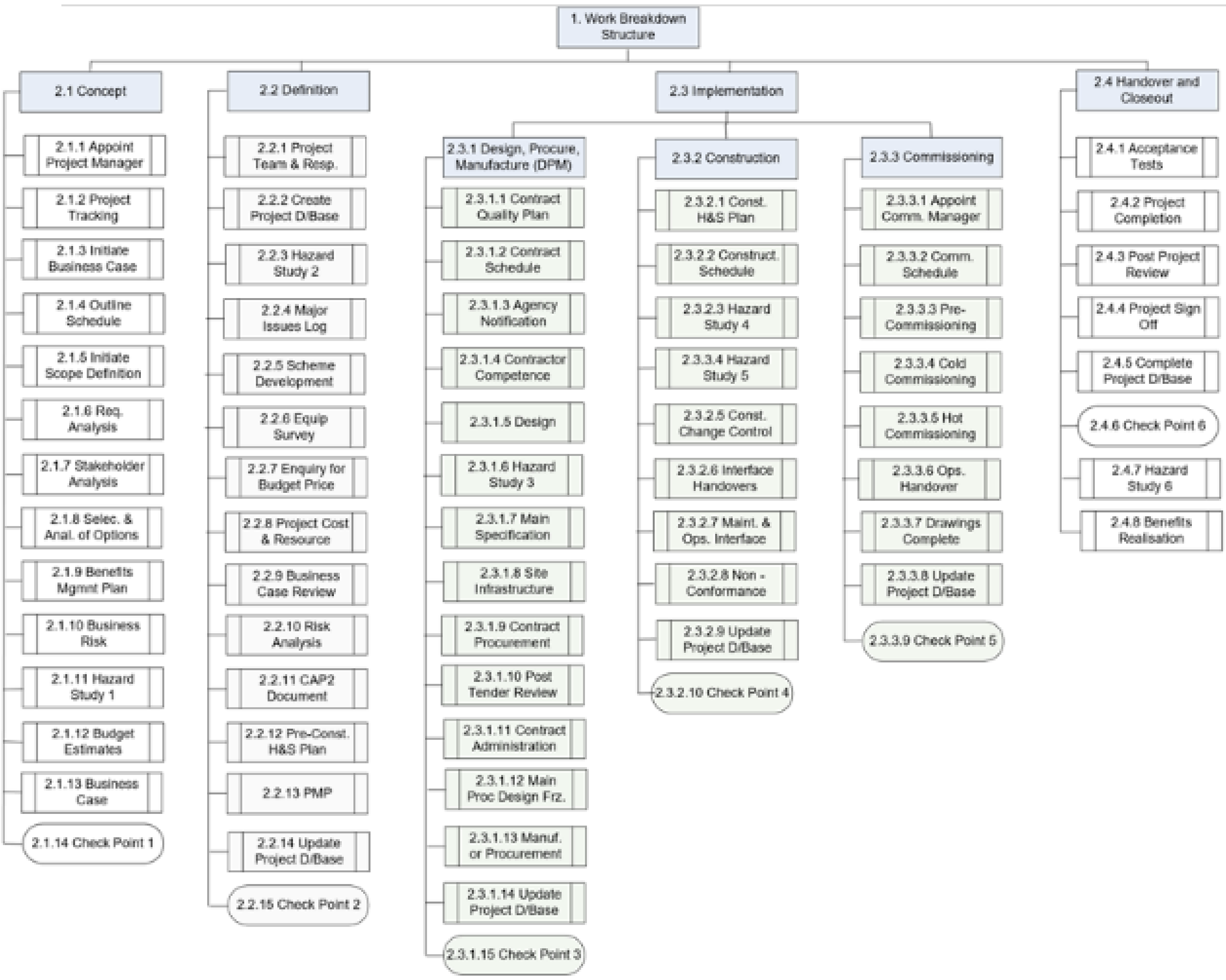

***Figure 36**: Work breakdown structure in Project Manual*

Each phase is made up of a number of activities that need to be carried out on a timely basis and, as can be seen above, phases 2 (Definition) and 3 (Implementation) are further broken down into more manageable sub-phases. The work breakdown structure for this approach is depicted in Figure 36 below. The applicant's approach to projects has been ratified against the structured methodology of the PRINCE2 (PRojects IN Controlled Environments) process model, which has been developed from the experiences of scores of projects, project managers and project teams.

The overall responsibility for project management within the applicant's organisation falls to the Business Management Team (BMT) comprising senior management representatives. The function of the BMT for Project Management is to:

- control and allocate the annual CAPEX spend
- ensure that a competent Project Management structure is in place
- monitor, review & steer capital plan
- categorise each project as major or minor CAPEX, which determines the level of Project Management required

The applicant's BMT will appoint a Project Manager for each capital scheme. The Project Manager's key tasks are to:

- establish and control a competent Project Team
- ensure the project process is followed
- ensure stakeholder communication
- plan checkpoint reviews for major CAPEX projects

The Design Services & Projects Department is responsible for project planning; resource planning and ensuring project reviews are carried out in accordance with agreed schedules, with the key tasks being to:

- control and administrate the applicant's Project Management Manual
- provide resource to develop and manage capital projects
- apply and promote the Project Management processes described in the Project Manual

All project reviews are held in accordance with the applicant's Project Management Project Categorisation System. There are two distinct levels of project review, 'major' and 'minor'. The Cr(VI) substitution project involves a new process/system and, as such, it is categorised as a major project. There are seven major checkpoint reviews required for major projects, all of which should be chaired by a senior manager. These reviews are carefully timed and executed to ensure that each phase of the project has been managed effectively. The checkpoint review includes a traffic light system which highlights where further measures are necessary.

All major projects must be fully controlled using the applicant's project management process. All relevant documentation must be prepared at all stages by the appropriate team member in readiness for the scheduled checkpoint reviews. To assist the effective management of projects, a set of standardised documents has been developed. The main objective of these documents is to summarise information in a format which makes it easy to understand project roles and responsibilities (see Table 15), project status and concerns. Each document is developed at a pre-determined period within each phase of a project and can be used at gate reviews (see Figure 37) as evidence that activities are complete.

Role	Responsibilities
Project Sponsor (Member of BMT) Senior management is responsible for the overall direction and management of the project and has responsibility and authority for the project within the remit (the project mandate). The Project Steering Committee is the project's 'voice' to the outside world and is responsible for any publicity or other dissemination of information about the project.	• **Project ownership and strategic oversight**: Accountable for the business case, overall project success, benefit realisation, legal compliance and post-implementation review. Owns the project vision, objectives and ensures alignment with strategic goals. • **Governance and decision-making**: Chairs the Project Steering Committee, approves or selects the Project Manager, secures funding, sets project KPIs and control boundaries, and authorises changes impacting the business case. Makes go/no-go decisions at phase gates. • **Support and escalation management**: Champions the project at senior levels, empowers the Project Manager, resolves escalated

Role	Responsibilities
	issues and ensures critical risks and issues are addressed through oversight of logs and registers. • **Communication and value assurance**: Promotes the project widely, articulates its importance at kick-off, ensures delivery of essential functionality only and avoids waste. Ensures the finished product meets compliance and safety standards.
Project Manager Has the authority to run the project on a day-to-day basis on behalf of the Managing Director within the constraints laid down by Senior Management or the Project Steering Committee. The Project Manager's prime responsibility is to ensure that the project delivers to the required standard of quality and safety within the specified constraints of time and cost. The Project Manager is also responsible for the project producing a result capable of achieving the benefits defined in the Business Case.	• **Team leadership & resource management**: Ensure the project team is adequately resourced, competently staffed, directed and motivated. Coordinate training and systems support for operations and maintenance. • **Project planning and execution oversight**: Develop and monitor plans, manage risks and contingencies, oversee budget and initiate corrective actions. Responsible for project administration and contract strategy, including contractor selection and negotiations. • **Governance and reporting**: Liaise with the Project Sponsor and Steering Committee to maintain project direction and integrity. Provide regular updates through reports and gate reviews, and agree on safety, technical and quality management strategies. • **Quality, safety and close-out**: Ensure independent reviews of process safety and plant integrity meet standards. Oversee the development and review of the Project Quality Plan and compile the final 'Lessons Learnt' report.
The Engineer The Engineer leads on all engineering issues and is accountable for the quality of engineering, including quality of the deliverables produced by contractors and suppliers. The Engineer has the authority to commit or acquire contractor resources.	• **Engineering leadership and coordination**: Lead and manage all engineering activities, ensuring effective coordination between designers, consultants, contractors and internal disciplines. Oversee design, procurement, installation and commissioning plans for capital equipment and infrastructure. • **Design integrity and safety assurance**: Ensure designs meet engineering standards, are safe to build, operate, and maintain, and incorporate feedback from production and maintenance teams. Manage change control, design freeze and configuration management processes. • **Project execution and documentation**: Plan and organise all project operations. Monitor and control budget, programme and contractual progress. Ensure complete documentation, including manuals, drawings and calculations, and coordinate snagging and handover activities. • **Stakeholder engagement and support**: Liaise with the Project Manager, escalate issues beyond control, support contract negotiations and lead training for operational teams. Ensure all work is carried out safely and in line with project requirements.
Project Engineers The Project Engineer's prime responsibility is to ensure delivery of those processes defined by the Engineer to an appropriate quality, in a timescale and at a cost acceptable to the Engineer and Project Manager. The Project Engineer reports to and takes direction from the Engineer or Project Manager.	• **Technical and commercial support**: Provide initial scheme assessments, recommend plant and equipment, evaluate tenders and support supplier selection and requisitioning. • **Project control and coordination**: Manage change control and configuration management. Monitor and control budget, schedule and contractual progress for specific contracts or disciplines, in coordination with the Engineer. • **Installation and quality assurance**: Ensure contractors deliver to specification and schedule, verify safe working practices and

Role	Responsibilities
	oversee the completion and proper storage of all required documentation, including QA records. • **Handover and post-installation support**: Liaise with the Works Area to resolve snagging issues and support a smooth transition post-handover.
Works Area Manager This role represents the interests of all those who will operate the final process, those of whom the process will achieve an objective or those who will use the process to deliver benefits.	The Works Area Manager is responsible for specifying the needs of those who will use the final product / process, for user liaison with the project team and for monitoring that the solution will meet those needs within the constraints of the Business Case in terms of safety, quality, functionality and ease of use. The Works Area Manager also commits user resource and monitors the process against requirements.

***Table 15**: Project management roles and responsibilities*

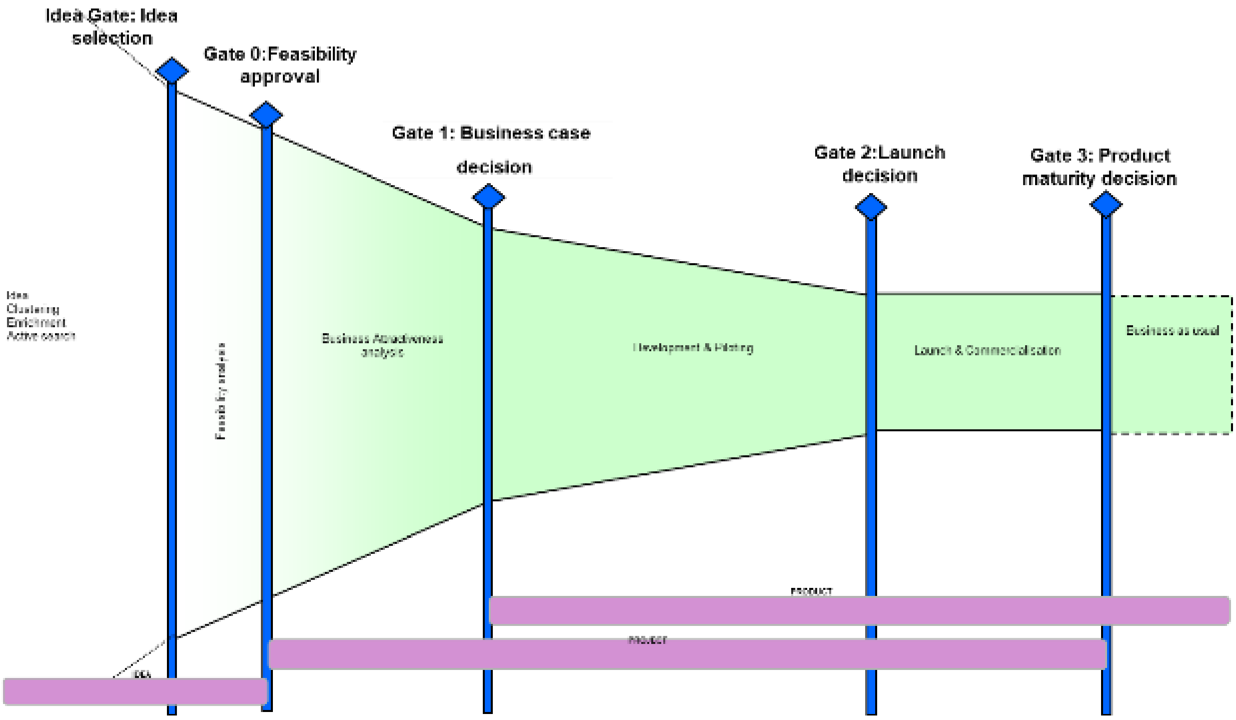

***Figure 37**: Gate reviews during the project management process*

4.5 Conclusions

The development of a new Cr(III)-based coating involves a series of structured steps, beginning with initial research and concept formulation, and progressing through testing, scale-up and eventual production. The duration of this process can vary significantly depending on the complexity of the coating, the availability of technical and financial resources, and the applicable regulatory requirements.

Based on the applicant's experience at the IJmuiden site, the general development pathway includes several key phases: early-stage research and feasibility studies, formulation and laboratory testing, pilot-scale trials, performance validation and, finally, industrial-scale conversion and implementation. Each phase builds upon the previous one, with iterative improvements and refinements made along the way to ensure the coating meets all functional, safety and quality standards.

This Substitution Plan highlights the applicant's commitment to developing, testing, trialling and ultimately industrialising and transitioning to a suitable alternative to chromium trioxide. Achieving this will require significant efforts and investments.

Currently, there are no suitable alternatives to chromium trioxide, as evidenced by the AoA (see section 3). All alternative substances and technologies currently fail due to their lack of technical feasibility. In other words, there is no 'drop-in' alternative available at this time. Consequently, substitution efforts are anticipated to last at least until 2043 and so **a review period of 15 years (from the end of the existing review period on 31 December 2027) is requested**. This period is based on the applicant's assessment of the time needed to industrialise a suitable alternative to chromium trioxide. However, given the numerous uncertainties, technical challenges and substantial economic investments involved in the substitution process, these periods may well extend significantly longer. It should also be noted that substitution represents a long-term solution that is not guaranteed to be successful.

5. Socio-Economic Analysis

Chromium trioxide is covered by entry 16 of Annex XIV and only authorised uses are permitted after the sunset date given in the entry (21 September 2017) unless otherwise exempted. As chromium trioxide is a non-threshold carcinogen, adequate control of risks cannot be demonstrated and therefore applications for authorisation must follow the socio-economic route.

This socio-economic analysis (SEA) has been undertaken as part of work to demonstrate the case for granting the applicant an authorisation to allow for continued use of chromium trioxide for the manufacture of ECCS during the requested review period of 15 years. The aim of the SEA is to assess and compare human health and socio-economic impacts of the continued use and of the non-use scenarios.

A period of 15 years (the review period requested) is used for the purposes of this assessment. The SEA considers the period between the date that use must cease in the event of a refused decision, assumed for the purpose of this assessment to be 31 December 2027 (the end of the existing review period), and 31 December 2042 (the end of the requested review period) in terms of the assessment of certain economic impacts. 2025 is used as the base year for calculations.

5.1 Continued use scenario

The continued use scenario, or applied-for use scenario (AFUS), has been outlined in section 3.1 of this report (taking into account the information in section 2 which provides the context and scope of the AfA). Further information on the applicant's use of chromium trioxide, as well as a detailed process description, appears in section 9 of the CSR.

During the review period, the applicant will continue efforts to identify and implement a suitable alternative to chromium trioxide. These activities are described in detail in the substitution plan in section 4 above, along with associated timescales, costs, challenges and uncertainties.

5.2 Risks associated with continued use

Chromium trioxide has been identified as a substance of very high concern (SVHC) under Article 57(a) and (b) of REACH and included on Annex XIV of REACH due to its carcinogenicity and mutagenicity. For this reason, the risk associated with continuous use of chromium trioxide focuses on human health. The risk to the environment is not required to be assessed for the authorisation of chromium trioxide, although releases to, and fate in, the environment are relevant for the assessment of human exposure via the environment.

The SEA assesses the health impacts attributable to the ongoing use of chromium trioxide in line with the scope of the applied for authorisation (i.e. considering the applied for use and review period). Such impacts are compared to the situation in the non-use scenario (NUS). Impacts beyond the UK are not strictly within the scope of this assessment, though the implications are considered where relevant for context and completeness.

5.2.1 Impacts on humans

The human health impacts that arise from the remaining risk associated with the exposure of humans to chromium trioxide in the applied for use scenario have been assessed. The potential health impacts relevant for this application for authorisation are lung cancer and gastrointestinal cancer associated with exposure to chromium trioxide via inhalation and ingestion respectively. The excess lifetime risk (ELR) for directly exposed workers and for the general population via the environment for developing lung cancer or small intestine cancer is derived based on the exposure assessment and on the existing reference dose-response function established for carcinogenicity of hexavalent chromium that was published by ECHA's Risk Assessment Committee (RAC).[18]

The risk associated with chromium trioxide relates to the hexavalent chromium ion, and the assessment of risk to human health is therefore based on exposure to the hexavalent chromium ion. The RAC document (RAC/27/2013/06 Rev.1) refers to chromium trioxide, hexavalent chromium and chromium (VI). The molecular weight of chromium trioxide is 100g/mol and the molecular weight of the hexavalent chromium ion is 52g/mol.

The assessment considers both workers that could be directly exposed to chromium trioxide in the course of their activities at the applicant's Trostre Works site and the general population, specifically residents and workers in the neighbourhood of the site that, hypothetically, could be indirectly exposed to releases from the site to the local environment.

The number of potentially exposed workers and members of the general population considered for the assessment are summarised in the table below. The number of different workers that may be in the scope of this assessment should not be confused with the full time equivalent (FTE) of the number of workers that carry out specific tasks (tasks may be shared between equally trained individuals). Workers that are not directly exposed to hexavalent chromium in the course of their activities are considered as part of the local general population for this assessment.

Group	Number
Workers at the Trostre Works (total, employees ([redacted]) plus permanent contractors ([redacted]))	[redacted] (public range: > 600)
Workers with one or more duties associated with the use of chromium trioxide	57 *
Local workers and residents (within a 1km radius of the site) (default)	10,000
Local workers and residents (within a 1km radius of the site) (actual, estimated)	< 3,822 **
Notes: * Consists of 28 ECCS production shift team members (20 of whom may also perform certain maintenance duties), 21 dedicated maintenance workers (5 Tata Steel employees and 16 contractors) and 8 wastewater treatment plant operators (Veolia employees) ** See Table 23 below for further information	

***Table 16**: Numbers of persons potentially exposed*

For the risk assessment of workers associated with ECCS production, the exposure route of concern is inhalation of dusts and mists or aerosols. Taking a conservative approach in line with the ECHA RAC paper (RAC/27/2013/06 Rev.1), in this assessment all particles inhaled are assumed to be respirable as a worst-case assumption for the risk assessment. Direct ingestion of chromium trioxide is not expected to occur considering workplace hygiene standards in place at the site. Therefore, the assessment of the health impact to workers directly exposed focuses on the risk of lung cancer associated with inhaling chromium (VI) in the course of work activities.

The assessment of health impacts in the general population considers both the risk of lung cancer relating to inhalation of chromium trioxide and the risk of intestinal cancer relating to the ingestion of chromium trioxide that may be released from the facility to the environment. The assessment considers release of

[18] ECHA, 2013.

chromium trioxide from the site to air and associated potential for exposure. Exposure via water is not considered because, as demonstrated in the CSR, chromium trioxide is not released to water from the site.

The relevant pathways for this assessment are summarised below:

Group	Inhalation	Ingestion
Workers (directly exposed)	✓	-
General population (indirectly exposed)	✓	✓

***Table 17**: Summary of relevant exposure pathways*

The health impact assessment evaluates the risk of developing cancer based on a detailed characterisation of exposure to chromium (VI) and the reference dose-response relationship for the chromium (VI) ion published by RAC (RAC/27/2013/06 Rev.1). The projected health impacts relating to these exposures are then characterised and valued in financial terms based on available guidance and data.

<u>Impacts on workers</u>

Worker exposure in the case of continued use is explained in the CSR. The CSR presents the estimated average exposures, based on measured and/or modelled data that is representative of the various activities (worker contributing scenarios) involving the continued use of chromium trioxide according to the operating conditions and risk management measures described in the exposure scenarios.

Measured data (personal sampling) is used in preference to modelled data where available. Measured data have been collected and analysed according to recognised standards, under representative conditions of personal exposure, and with sufficient data points over a number of years to provide confidence that it best reflects the real-life exposure situation. However, modelled data are also provided for the limited number of worker contributing scenarios (WCS) where measured data are not available.

The estimated exposure for the WCS set out in the CSR is summarised in the table below. The average exposures presented for each activity are time-weighted over either a 12-hour or 8-hour period depending on the shift length of the workers concerned. They account for both duration and frequency of tasks that contribute to exposure in a representative working day. They also take account of respiratory protective equipment consistent with the WCS.

WCS	Activity	Est. exposure [1] µg/m³	Number of workers exposed [2]
WCS1	Receipt, transport and storage of chromium trioxide	7.96E-08	4
WCS2a	Sampling of the electrolyte solution: taking samples	2.29E-03	See WCS 2b [3]
WCS2b	Sampling of the electrolyte solution: laboratory analysis	9.17E-02	4
WCS3	Dissolving chromium trioxide in the circulation tank	2.29E-03	See WCS 2b [3]
WCS4	Electroplating	2.89E-01	4
WCS5	Control room activities	2.31E-01	8
WCS6	Loading and unloading of steel coils	7.88E-02	8
WCS7a	Maintenance activities: all activities except confined space entry - workers on 12 hour shifts	2.64E-04	20

WCS	Activity	Est. exposure [1] µg/m³	Number of workers exposed [2]
WCS 7a	Maintenance activities: all activities except confined space entry - workers on 8 hour shifts	1.11E-03	21
WCS7b	Maintenance activities: confined space entry	1.34E-04	2
WCS8a, WCS8b	Waste management including wastewater treatment	3.38E-02	8

Notes:

[1] Estimated exposure per worker as either 12 hour or 8 hour-TWA depending on the relevant shift length in question and is adjusted for frequency of task and RPE. Based on results of personal sampling with supplemental ART modelling where required (see CSR).

[2] Maximum number of workers who may carry out these activities. To avoid double-counting, this totals 28 for WCS1 to WCS6 inclusive, split across the various WCS, to reflect the total number of ECCS production shift team members.

[3] One operator (the chemical additions operator) performs the tasks described under WCS 2a, WCS 2b and WCS 3 per shift. The highest ELR for this SEG is therefore used to avoid double-counting.

***Table 18**: Estimated worker exposure for the worker contributing scenarios (WCS)*

As discussed above, ECHA's RAC derived a linear reference dose response relationship which describes the additional (excess) risk, up to the age of 89, of workers dying from lung cancer due to exposure to the chromium (VI) ion in the workplace. This states the excess lifetime lung cancer mortality risk for workers for the purpose of an application for authorisation is 4 x 10^{-3} per µg Cr(VI)/m^3. According to this model, there is no minimum threshold for effects. It assumes exposure occurs over a 40-year working life (8 hours a day, 5 days a week).

This excess lifetime lung cancer mortality risk for workers value is adapted for use in the application for authorisation by factoring for the duration of the requested authorisation (assumed to be 15 years) as opposed to 40 years. The number of working days per year is also adjusted from 5 days per week over 52 weeks (260 days) to the number of working days, as appropriate, for each activity or WCS. The additional risk of a fatal lung cancer for each activity is calculated as the product of this adjusted unit risk value and the exposure per worker carrying out the activity. The additional risk of a fatal lung cancer across the workforce is the sum of these risks across all workers, considering all relevant activities for each worker.

The RAC dose-response relationship relates to cancer mortality risk. It does not explicitly consider the excess risk of developing and surviving lung cancer due to exposure to chromium trioxide over the duration of the authorisation. This risk is separately determined considering the excess lifetime lung cancer mortality risk and data on cancer survival. Available data indicate the age-standardised relative survival rates (average for men and women) for lung cancer in the UK over 10 years is 9.5%[19]. This would mean that the UK fatality rate for lung cancer is 90.5% over 10 years and an additional 0.105 (=9.5/90.5) non-fatal cancer cases typically occur for every fatal cancer case in the UK.

Total worker excess cancer risk	Lifetime	Per year
Additional fatal lung cancer risk	6.45E-03	4.30E-04
Additional non-fatal lung cancer risk	6.77E-04	4.52E-05
Total	7.13E-03	4.75E-04

***Table 19**: Total worker excess cancer risk for review period (15 years)*

[19] ONS, 2019.

The valuation of these potential additional fatal and non-fatal cancer cases has been calculated based on values of a statistical life (VSL) and for morbidity due to cancer (VCM) published by ECHA[20] and adjusted from 2012 to the base year (2025) with reference to gross domestic product (GDP) deflator indexes[21] and the current exchange rate[22] for Euro and UK £.

Value	Lower bound EUR 2012	Lower bound [1] EUR 2025	Lower bound [2] UK £ 2025	Upper bound EUR 2012	Upper bound [1] EUR 2025	Upper bound [2] UK £ 2025
Value of statistical life (VSL)	3,500,000	4,928,824	4,304,824	5,000,000	7,041,177	6,149,060
Value of cancer morbidity (VCM)	410,000	577,376	504,223	410,000	577,376	504,223
[1] The 2012 values adjusted by 1.41 (rounded) based on the UK GDP deflator of 2025 compared to 2012. [2] Exchange rate EUR : GBP = 0.8733						

***Table 20**: Valuation of potential additional fatal and non-fatal cancer cases*

Lung cancer has a latency period of around 10 years. To account for this, the values (VCL and VCM) are discounted (at a rate of 4% in accordance with ECHA guidance) over a 10-year period.[23] Based on these adjusted values:

- the value of (avoiding) a fatal cancer is £3.25 million (lower bound) to £4.49 million (upper bound)
- the value of (avoiding) a non-fatal cancer is £0.34 million

Applying a lower discount rate of 2% to account for an increased value on health and safety in accordance with improved living standards in the UK since 2012:

- the value of (avoiding) a fatal cancer is £3.94 million (lower bound) to £5.46 million (upper bound) and the value of (avoiding) a non-fatal cancer is £0.41 million.

The health impact cost of continued use (or benefit of a discontinued use) is calculated as the product of the total excess lifetime risk, based on exposure across all workers and activities over the duration of the requested review period, and the adjusted value of one additional lung cancer case, considering both fatality and survival outcomes and rates. Thus, the starting point for the valuation for lung cancer is lung cancer fatality. This is adjusted to include the associated cost of non-fatal lung cancer based on UK survival rates.

The monetised health impacts for workers potentially exposed to chromium trioxide are summarised in the table below.

	Lower bound * UK £	Upper bound ** UK £
Lung cancer [fatal and non-fatal] during the review period (15 years)	23,421	39,233
Notes: * 4% discount rate ** 2% discount rate		

***Table 21**: Summary of monetised health impacts for potentially exposed workers*

[20] ECHA, 2016 (a).

[21] HM Treasury, 2024.

[22] Financial Times, accessed 7 August 2025, available from https://markets.ft.com/data/currencies/tearsheet/summary?s=eurgbp

[23] ECHA, 2016 (a), at p41.

Impacts on the general population

Releases of chromium trioxide to the environment from the Trostre Works site are minimised. Wastewater treatment results in the complete reduction of Cr(VI) to Cr(III) prior to release. No Cr(VI) has been detected in wastewater discharged to the estuary (see CSR for further details).

Air above the plating baths and from the recirculation tanks is extracted and discharged via wet scrubbers through one of two stacks. Measurements of total chromium in the air discharged from the stack have been used to predict environmental concentrations (e.g. concentrations in air 100m from the site and in the food chain) and are presented in the CSR.

Environmental parameter	Predicted concentration
Predicted concentration in air 100m from the stack	1.51E-05 mg Cr(VI)/m^3
Predicted concentration in surface water	0.00 mg Cr(VI)/l
Predicted concentration in regional air	2.87E-17 mg Cr(VI)/m^3
Predicted concentration in regional water	0.00 mg Cr(VI)/l
Predicted uptake humans via the environment (oral)	1.36E-04 mg Cr(VI)/kg bw/d

***Table 22**: Summary of predicted environmental concentrations relating to releases from the site*

The risk assessment considers exposure of people living and working locally, in the vicinity of the Trostre Works. The site is situated within the county of Carmarthenshire, 1.5 km to the east of the town of Llanelli. There are several small villages within a 5km radius. The village of Llwynhendy is situated within 1 km of the site boundary. The Trostre Business Park and Trostre Retail Park are situated within 0.5 km to the west of the site boundary and the Pemberton Retail Park and 15,000 capacity Rugby Stadium (Parc Y Scarlets) are situated within 0.5 km to the north of the site boundary. The Wildlife and Wetlands Centre, Wales, is located to the south of the site, approximately 0.5 km from the site boundary.

The default number of local people in the vicinity of any site that may be exposed on a local scale is 10,000 (based on ECHA guidance[24]). However, this number significantly overestimates the actual number of people within 1km of the stack where emissions can occur. Figures 38 and 39 below show that the main residential areas surrounding the Trostre site are over 1km from the stacks, with a limited presence of domestic areas within that zone. Commercial parks, an industrial park, a rugby stadium and the rest of the Trostre Works site itself comprise the main areas within 1km of the stacks.

A more realistic (whilst still conservative) estimate of the total number of people (local population and visitors) within 1 km of the stacks is 3,822, as detailed in the table below.

Population centre	Population / visitors (estimated maximum number)	Number taken forward for assessment	Notes
Llwynhendy (electoral ward, 2021 census data)	4,389 (permanent)	1,463	Approximately one-third of domestic premises in the Llwynhendy electoral ward are within 1km of the stacks. 4,389 x 1/3 = 1,463 No further reduction is made for duration of time people will actually be present in their houses to ensure a conservative approach is taken to the assessment.

[24] ECHA, 2016 (b).

Population centre	Population / visitors (estimated maximum number)	Number taken forward for assessment	Notes
Trostre Retail Park & Trostre Industrial Estate	3,000 (transient)	1,000	Assumes retail park and industrial estate operate all year round, 12hrs/day. Reduction of a further third is made for off-peak times. 3,000 x (12/24) x (2/3) = 1,000
Pemberton Retail Park	2,500 (transient)	833	Assumes retail park operates all year round, 12hrs/day. Reduction of a further third is made for off-peak times. 2,500 x (12/24) x (2/3) = 833
Parc Y Scarlets Rugby Stadium (match day)	14,870 capacity, though average match day crowd <7,000 (transient)	80	Assume 25 matches per year, each event of up to 4hrs duration (between doors open/close). 7,000 x (25/365 days) x (4/24 hrs) = 80
Wetlands and Wildlife Centre	Up to 50,000 visitors per year (transient)	46	Open all year round for between 9.30am-5pm. 50,000/365 x (8/24 hrs) = 46
Workers at the Trostre Works itself	Approximately [redacted] employees and [redacted] permanent contractors	400	Of the [redacted] total, the number of workers (employees and permanent contractors) on-site at any one time will not exceed 400. (NB. No further deduction is made for the 57 workers already accounted for in the total number of workers covered by each WCS (see CSR).)
TOTAL		**3,822**	

***Table 23**: Information on local population around the site*

An aerial view and map with the site boundary and areas within a 1 km radius of the stacks serving the ECCS line are provided in Figures 38 and 39 below.

The local population is assumed to be exposed to the local predicted concentration of total chromium (as a proxy for Cr(VI)) in air, i.e. the concentration 100m from the point source, calculated as a yearly average in accordance with ECHA guidance.[25] This is a worst-case assumption, not least because the concentration of Cr(VI) in air will be less than the concentration of total chromium.

Changes in the regional concentration of Cr(VI) in air from releases at the site are not considered in this assessment. Several published reports including the EU risk assessment report (RAR) for chromium trioxide[26] identify Cr(VI) will normally be reduced to trivalent form under environmental conditions and conclude the risk relating to exposure on regional scale is negligible.

As discussed, RAC-derived linear reference dose response relationships describe the additional (excess) risk of the general population of fatal lung cancer and of developing intestinal cancer due to exposure to chromium (VI). According to the RAC document, the excess lifetime lung cancer mortality risk for the general population is 2.9×10^{-2} per µg Cr(VI)/m^3 and the excess lifetime intestine cancer risk for the general population is 8×10^{-4} per µg Cr(VI)/kg.bw/day. These values are used in the risk assessment. The dose-response relationships for the general population assumes exposure occurs over a 70-year period (24 hours a day, 7 days a week) and assumes there is no minimum threshold for these health effects.

[25] ECHA, 2016 (b).

[26] European Chemicals Bureau, 2005.

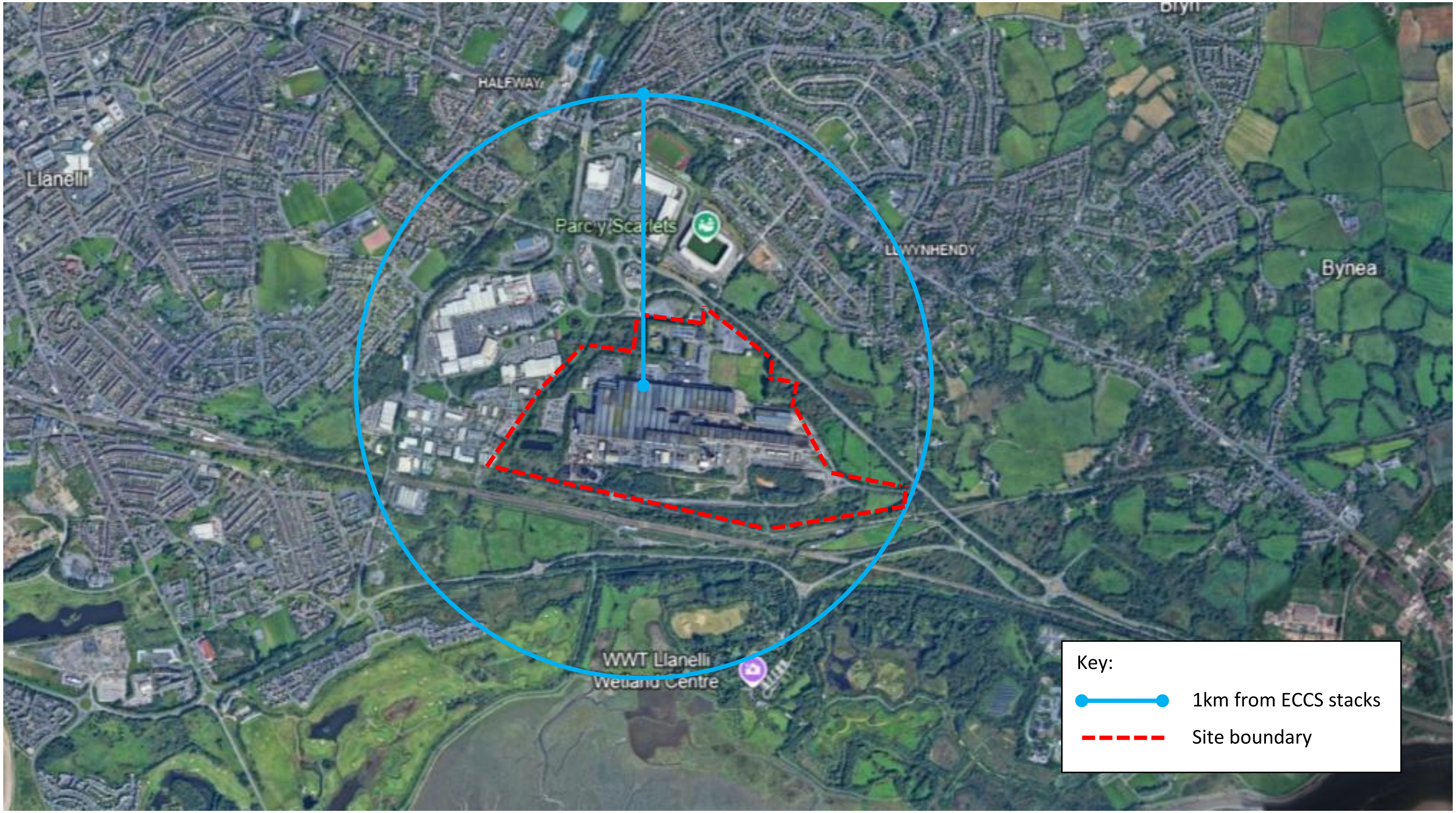

***Figure 38**: Overhead view of the Trostre Works showing the site boundary and area within a 1 km radius of the exhaust stacks from the ECCS line*

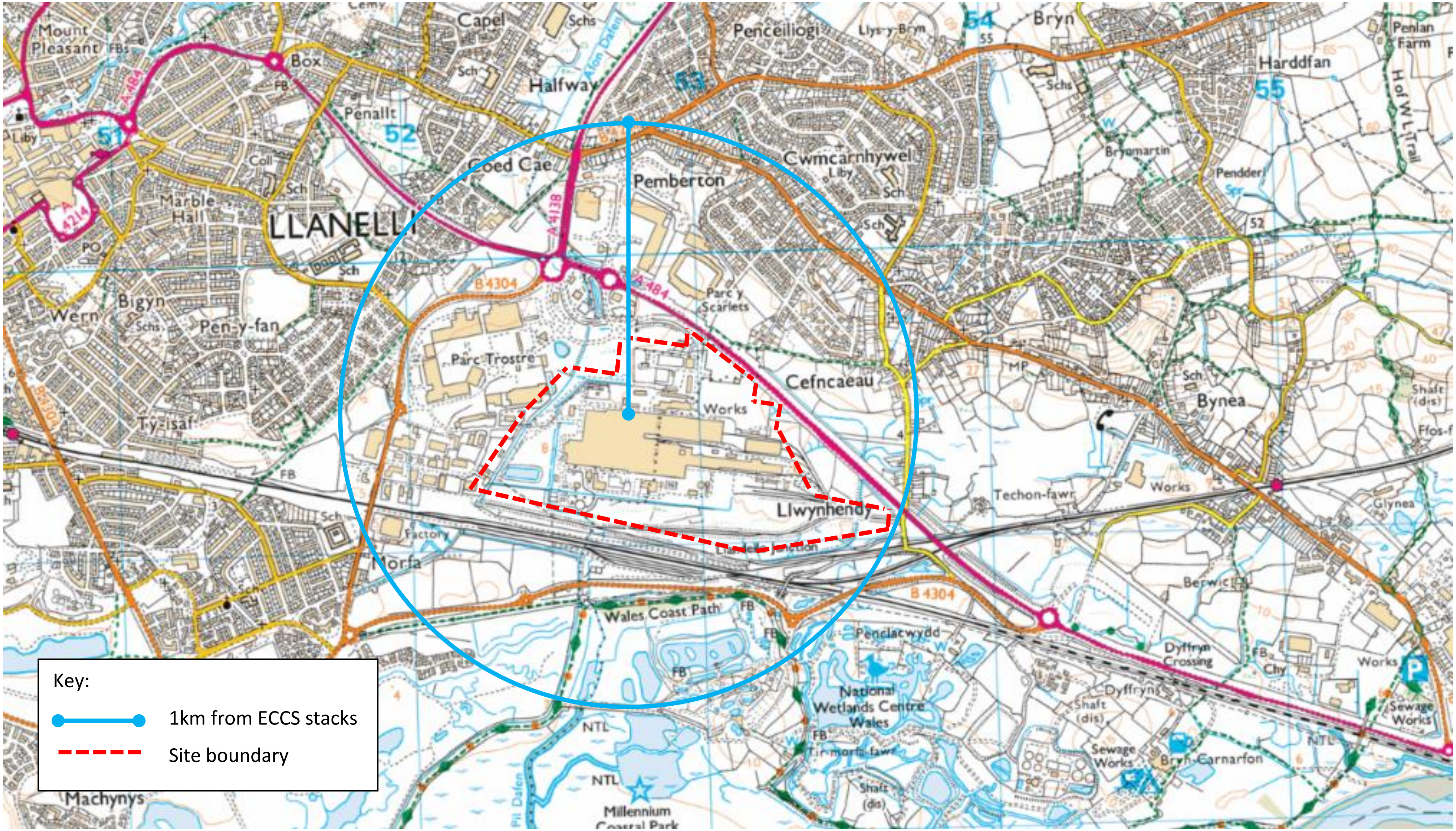

Figure 39: OS map (1: 25,000 scale) showing the Trostre Works site boundary and area within a 1 km radius of the exhaust stacks from the ECCS line

These excess lifetime risk values are adapted for use in the application for authorisation by factoring for the duration of the review period requested (15 years) as opposed to 70 years. The assessment considers everyone in the general population to be a resident as a worst case, although in reality the majority of those within 1km of the site will be workers at the Trostre Works (employees and permanent contractors), workers at other nearby businesses, and transient populations, e.g. visitors to nearby retail sites. As the dose-response relationship relates to mortality for lung cancer and incidence for intestinal cancer, the detailed methods for the cost calculations for lung cancer and intestinal cancer differ accordingly.

The approach to calculating fatal and non-fatal lung cancer cases and associated costs is consistent with the approach described for workers.

The age-standardised five-year survival rates for small intestinal cancer in the UK (average of men and women) is 53%, meaning the UK fatality rate for intestinal cancer is 47% over 5 years[27] and an additional 1.13 (=53/47) non-fatal cancer cases typically occur for every fatal cancer case in the UK. The latency period is 26 years.[28]

The additional risk of developing intestinal cancer is the product of the adjusted unit risk value and the average exposure across the population.

The health impact cost of continued use (or benefit of a non-authorisation) for intestinal cancer is calculated as the product of the total excess lifetime risk, based on exposure across the local population over the duration of the requested review period, and the adjusted value of one additional intestinal cancer case, considering both fatality and survival outcomes and rates. The valuation of avoided intestinal cancer is thus the sum of the VCM and the fatality rate multiplied by VSL.

The monetised health impacts for the general population in the vicinity of the Trostre Works site are summarised in Tables 24 and 25 below. Table 24 sets out the monetised health impacts over the requested review period (15 years) and Table 25 sets out the monetised health impacts per year of the review period. The impacts for both the default (10,000) and realistic (3,822) local populations are presented, although the realistic figures are used for the assessment.

	Lower bound (UK £)	Upper bound (UK £)
Potentially indirectly exposed local workers and residents (within a 1km radius of the site) (default) [1]		
Lung cancer [fatal & non-fatal]	3,090,719	5,177,246
Intestinal cancer [fatal & non-fatal]	217,048	483,631
Total for 15 years	3,307,767	5,660,876
Potentially indirectly exposed local workers and residents (within a 1km radius of the site) (realistic) [2]		
Lung cancer [fatal & non-fatal]	1,181,273	1,978,743
Intestinal cancer [fatal & non-fatal]	82,956	184,844
Total for 15 years	1,264,229	2,163,587
Notes: 1 = Based on a local population of 10,000 people. 2 = Based on a local population of 3,822 people, see Table 23.		

***Table 24**: Summary of monetised health impacts for general population over the requested review period*

[27] Cancer Research UK, available at https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/small-intestine-cancer
[28] Nadler, D.L. and Zurbenko, I.G., 2014.

	Lower bound (UK £)	Upper bound (UK £)
Potentially indirectly exposed local workers and residents (within a 1km radius of the site) (default) [1]		
Lung cancer [fatal & non-fatal]	206,048	345,150
Intestinal cancer [fatal & non-fatal]	14,470	32,242
Total per year	220,518	377,392
Potentially indirectly exposed local workers and residents (within a 1km radius of the site) (realistic) [2]		
Lung cancer [fatal & non-fatal]	78,752	131,916
Intestinal cancer [fatal & non-fatal]	5,530	12,323
Total per year	84,282	144,239
Notes: 1 = Based on a local population of 10,000 people. 2 = Based on a local population of 3,822 people, see Table 23.		

***Table 25**: Summary of monetised health impacts for general population per year (considering a requested review period of 15 years)*

5.2.2 Impacts on the environment

The environmental impacts are not included in the impact assessment of the continued use, since in Annex XIV of REACH chromium trioxide is not listed for risks to the environment but for human impacts only, as a carcinogen (cat. 1A) and mutagen (cat. 1B), in accordance with Article 57 (a) and (b) of REACH.

5.2.3 Compilation of human health and environmental impacts

This section calculates the risk to human health relating to continued use at the Trostre Works. The table below summarises the findings of the assessment of the impact to human health of continued use of chromium trioxide for the manufacture of ECCS for a further 15 years, to 2043.

	Excess lifetime cancer risk [1]	No. of exposed people	Est. statistical cancer cases ([per year] [4] [over 15 years]) [5]	Value per statistical cancer case (2025) GB £	Monetised excess risk ([per year] [4] [over 15 years]) [5] GB £
Workers					
Directly exposed workers [2]	4.78E-10 to 2.78E-03	57 [6]	4.75E-04 per year 7.13E-03 total	3.25 million to 5.46 million	1,561 to 2,616 per year 23,421 to 39,233 total
Indirectly exposed workers [3]	See below	See below	See below	See below	See below
General population					
Local	9.41E-05 lung 2.33E-05 intestinal	3,822 (realistic)	3.60E-01 lung 8.90E-02 intestinal	3.25 to 5.46 million (lung) 0.93 to 2.08 million (intestinal)	84,282 to 144,239 per year 1,264,229 to 2,163,587 total

	Excess lifetime cancer risk [1]	No. of exposed people	Est. statistical cancer cases ([per year] [4] [over 15 years]) [5]	Value per statistical cancer case (2025) GB £	Monetised excess risk ([per year] [4] [over 15 years]) [5] GB £
Regional	N/A	N/A	N/A	N/A	N/A
Totals					**85,843 – 146,855 per year** **1,287,650 – 2,202,820 total**

Notes:

1. Excess risk is estimated over a typical lifetime working exposure (40 years) and via the environment over a typical lifetime exposure (70 years) and is adjusted for the requested review period. As excess risks differ depending on the task, the overall minimum and maximum excess risk among of all the tasks carried out by the workers is reported.
2. Directly exposed workers perform tasks described in the worker contributing scenarios, typically characterised by a 12-hour Time Weighted Average (TWA) exposure of a representative worker.
3. Indirectly exposed workers (bystanders) do not use the substance. They have been assessed as part of the general population.
4. Per average year during the time horizon used in the analysis.
5. Derived from the lifetime risk of 40 or 70 years.
6. Total number of workers carrying out one or more tasks involving chromium trioxide.

***Table 26**: Summary of additional statistical cancer cases for human health*

	Per year	Over 15 years
Total releases/emissions (in kg per period)	Water: 0 kg/year Air: 15.81 kg/year Soil: 0 kg/year	Water: 0 kg Air: 237.15 kg Soil: 0 kg

***Table 27**: Summary of remaining releases to the environment*

The range of values presented predominantly reflects uncertainty in the VSL and the discount rate applied during the assessment.

The impact assessment over-estimates exposure considering, for example, the assessment assumes the general population is exposed to calculated total chromium (as a proxy for Cr(VI)) concentrations 100m from the stacks. In reality, concentrations will diminish with distance so the average concentration will be far lower. In addition, the ECHA dose response relationship assumes no threshold for effects. However, the ETeSS study[29] on which it was based states that "*…the lower the exposure (certainly below 1µg/m^3), the more likely it is that the linear [dose-response] relationship overestimates the cancer risk*". The study further states that "*the risk estimates for … exposures lower than 1 µg Cr(VI)/m^3 might well greatly overestimate the real cancer risks. It is also considered that at progressively lower Cr(VI) air concentrations (from about 0.1 µg/m^3 downwards), cancer risks may be negligible*". The calculated air concentration 100m from the point source is 1.51E-02 µg/m^3 and thus over 6 times lower than the concentration at which cancer risks may be negligible.

[29] ETeSS, 2013.

5.3 Non-use scenario (NUS)

The non-use scenario (NUS) is defined as what the applicant will do, and what will happen more generally, if an authorisation is refused and they must cease using chromium trioxide for the manufacture of ECCS. The following section constitutes the derivation of the most-likely NUS for the applicant if their application for authorisation is refused, given that there is no possibility of immediate substitution to an alternative. The assessment is based on technical and economic considerations which give rise to the choice of the most likely scenario.

5.3.1 Identification of plausible non-use scenarios

The applicant has identified and evaluated the following nine different NUS considering the likely impacts and associated responses of each, to determine the most realistic NUS in the event of a refused authorisation:

A. Partial site closure
B. Total site closure
C. Prolonged production downtime
D. Rationalisation (reduction) of the ECCS product portfolio
E. Outsourcing electroplating to a third party based outside the UK and EU
F. Outsourcing electroplating to a third party based in the UK or EU
G. Relocation of electroplating facility
H. Stockpiling
I. Use of a supplier with an upstream authorisation that covers the use

These NUS are explored further below.

Scenario A: Partial site closure
This scenario considers ceasing the production of ECCS at the Trostre Works but attempting to continue manufacturing ETP (tinplate), i.e. attempting to switch all production to products that do not require the use of chromium trioxide. It therefore represents a partial site closure (closure of the ECCS line).

This scenario was not considered realistic by the applicant. The scenario involves the loss of around [redacted] (public range: 150-250 kt/year) of ECCS products (and the opportunity to process a certain quantity further on the Protact line) from a total of around [redacted] (public range: up to 400,000 kt/year) , based on the applicant's 2026 business plan. Even if ETP production continued, the Trostre Works would not remain competitive on international markets without a full product range and the profits from ETP alone would not absorb the fixed costs of operating the site. Those fixed costs are based on production levels of up to 400 kt/year spread across all operations. The site is currently running at full capacity and the applicant expects this to continue.

The applicant would also lose the additional market for material sold which does not ultimately become ECCS, e.g. material that is out of specification. The applicant currently uses approximately [redacted] of feedstock to produce around [redacted] of ECCS and some of the yield loss can be sold.

In addition, it is vital to keep both coating lines (ETP and ECCS) open due to the high level of integration of the plant, which is optimised to produce both ETP and ECCS. The plant design assumes production flow is maintained to both lines; the coating lines would otherwise act as a bottleneck if only one line was running, which would lead to regular upstream production issues and stoppages.

It would not be feasible to convert the ECCS line to a second ETP line in an attempt to increase ETP production and compensate for the loss of ECCS, for various reasons, e.g.

- As the sole UK producer of packaging steel, customers currently expect the applicant to be able to offer a full range of packaging steel products, not just those based on ETP.
- While the ECCS market is healthy and could indeed grow, it is not necessarily the case that the ETP market is large enough to fill any gap created by the loss of ECCS, i.e. there is no guarantee that demand would be sufficient
- Any new ETP line would require substantial investment, which may not be available, especially if the market for increased volume of products is unproven, also taking into account competition from within Tata Steel itself across its different plants that serve different global markets.
- It would take many years to design, install and commission a new line. As noted above, during this time, the fixed costs associated with operating the site would not be absorbed and running a single line would cause very significant production problems due to the level and complexity of plant integration.
- Production of ETP itself relies on a REACH authorisation (for sodium dichromate) which also needs to be extended past the current review period expiry date (31 December 2027). Any reasons for refusing an authorisation for the use of chromium trioxide for ECCS would likely apply to the use of sodium dichromate for ETP.

Scenario B: Total site closure

This scenario is similar to the 'close' NUS option in the initial application for authorisation. It is also the logical outcome of Scenario A above, which demonstrates that ceasing production of ECCS at the Trostre Works also leads to ceasing ETP production, as it would no longer be viable to continue operating with one coating line (ETP) only, nor would it be feasible to convert the ECCS line to an ETP line. Production would therefore cease and the site would have to be closed, with the subsequent impacts on revenue, profits, jobs and the supply chain that this entails.

As well as the impacts at Trostre itself, this scenario would also have significant implications for the applicant's customers. The applicant is the primary producer of packaging steel in the UK and the Trostre Works is well-positioned to the size and demands of the UK market. Closure of the Trostre Works would have significant implications for its customers who are heavily reliant on its products. The applicant does not have a clear picture of how its customers may respond in the event of a closure of Trostre but it is credible that it would lead to closures of (or significant restructuring within) those businesses, with packaging manufacturing operations being moved abroad.

The applicant's operations are highly integrated, meaning that the loss of the Trostre Works would have implications for the competitiveness, profitability and feasibility for operations across the wider company. Most significant would be the implications for the new EAF-based steel making facility at Port Talbot, a £1.25 billion project expected to be operational by early 2028 that will enable the applicant to supply the market with low-CO_2 steel. Once up and running, that facility will supply the Trostre Works with hot rolled coil (HRC) for future ECCS and ETP production, [redacted]. Closure of Trostre would therefore result in a loss of [redacted] (public range: up to 500 kt/year) of HRC supplied from Port Talbot, from its initial projected production output of [redacted] (public range: up to 3.2 Mt/year).

The loss of [redacted] of HRC (public range: up to 500 kt/year), around [redacted] of all HRC to be produced initially, would fundamentally affect the production assumptions on which the EAF facility is based. The projected [redacted] (public range: up to 3.2 Mt/year) of HRC is based on supply to other of the applicant's sites, including Trostre, Hartlepool, Shotton, Corby and Newport. The applicant would not be able to compensate for the loss of [redacted] of HRC (public range: up to 500 kt/year) to Trostre by increasing volumes supplied to these other sites, as they would already be at capacity. The applicant would therefore either have to find a market for the 'excess' HRC to be produced at Port Talbot, or alternatively decrease production volumes from those currently planned.

Both of these eventualities undermine the basis upon which the EAF facility is moving ahead. Business plans were based on a production volume of [redacted] (public range: up to 3.2 Mt/year) of HRC, so it is not financially viable to simply reduce the amount of HRC to be manufactured at Port Talbot by [redacted] (public range: up to 500 kt/year). Neither would it be financially viable to attempt to sell the 'excess' quantity of HRC that would become available from any closure of Trostre. HRC is a lower-value, commodity product, so selling HRC represents a significant loss in value for the applicant. In the steelmaking industry, higher added value comes from differentiation, i.e. processing finished steel products through various manufacturing techniques (including ECCS and ETP), or through product development and related services, ultimately leading to higher profitability. The more processing steps there are, the greater the value that is created. The fewer, the less financially viable and more vulnerable the model is.

Manufacturing ECCS and ETP at Trostre typically contributes at least [redacted] per tonne (public range: > £500) of added value to HRC. In addition to impacts associated with a closure of Trostre itself, ceasing production of ECCS and ETP at Trostre would result in an overcapacity of HRC at Port Talbot of [redacted] (public range: up to 500 kt/year). The applicant would be forced to place this excess HRC on the market, representing a loss of up to [redacted] (public range: up to £250 million per year) in added value, perhaps more, a figure which does not take into account any further reduction in the price of HRC due to there being excess available on the market.

The applicant's EAF project, one of the largest industrial transition projects in the UK, is crucial for the company's future success, enabling greener, more efficient, and resilient steel production, while also enhancing supply security and competitiveness. For instance, the new assets will reduce the UK's entire industrial carbon emissions by 8% (and Port Talbot's by 90%) while setting a benchmark in circularity by utilising UK scrap, reducing reliance on imported raw materials and creating more stable, locally-rooted supply chains. Closure of Trostre would undermine and destabilise the EAF business model, which is based in part on a £500 million Grant Funding Agreement (GFA) with the UK Government. The GFA recognises the importance of the green steel transition, the need to decarbonise the UK's steel sector whilst safeguarding the UK's steel sovereignty and national resilience, as well as secure steel making in Port Talbot and preserve over 5,000 jobs.

Packaging is a key market for the applicant upon whose products and services its customers are heavily reliant. It is also strategically important for the applicant to ensure diversity of its markets (such as construction, automotive, packaging and engineering) to protect it against fluctuations in those markets. For instance, when the construction or automotive sectors are down, the packaging sector will usually be up. Sales of packaging products are vital to the resilience and flexibility of the applicant's business model. Retaining or closing the Trostre Works was considered as part of the EAF business plan because manufacturing packaging steel from EAF-based HRC introduces operational challenges (given that EAF steel production primarily uses scrap steel as the primary feedstock). The decision was to retain the site, as a major recipient of the HRC to be produced at the new EAF facility.

Scenario C: Prolonged production downtime

This scenario explores a temporary cessation of production of ECCS at the site while a suitable alternative (e.g. a Cr(III)-based process) is identified and implemented (involving the design, construction and commissioning of a new production line). This is similar to the 'open' NUS option in the initial application for authorisation, but this was based on the assumption that TCCT would be capable of being a credible alternative for all ECCS products, which has not since turned out to be the case.

This scenario was not considered realistic. A temporary cessation of the production of ECCS also means a temporary cessation of the production of ETP, i.e. a full site shutdown, given the high degree of plant integration (as explained in Scenario A above). This would mean Trostre would generate no revenue for the applicant for an undetermined number of years. In turn, this would likely mean it would not be possible to raise the funds (CapEx) for a new line, given that Trostre would be making no revenue or profit.

As demonstrated in the Analysis of Alternatives, no suitable alternative is currently available and, as demonstrated in the Substitution Plan, it will take many years to identify and qualify a suitable alternative, assuming this even proves possible. If and when a suitable alternative is found, it will then take many years to implement a new production line and complete all necessary pack tests etc. Even if production could resume, by then, the applicant's customers would have gone elsewhere and the applicant's market share would be lost, with it being very difficult to reclaim it.

The above means that the period of production downtime would, in reality, be expected to last for the duration of the requested review period. In addition, the impacts on the EAF project described above under Scenario B would equally apply.

Scenario D: Rationalise (reduce) the ECCS product portfolio at Trostre

This scenario examines whether it would be possible to limit ECCS production to only those products for which a Cr(III)-based alternative, e.g. TCCT, is capable of acting as a suitable alternative. TCCT is qualified and commercially available for Tata Steel's Protact products and the Trostre Works already has a Protact laminating line.

However, TCCT is only currently capable of producing Protact products and is not a suitable alternative for other (non-Protact) ECCS products made at Trostre. Protact-laminated packaging steel only represents approximately 10% [redacted] of Trostre's annual ECCS output, i.e. Protact is currently only a small part of Trostre's ECCS business.

In the event of a refused authorisation, non-Protact products could no longer be produced, i.e. 90% of the current ECCS output, and the applicant would experience substantial impacts associated with the related loss of revenue and profit. It would also have significant implications for the viability of the EAF project, as explained in Scenario B above.

It may be possible to grow the Protact business to some extent, to compensate for the loss of other products. However, any such growth would not come close to fully compensating for that loss. The applicant's customers expect and demand the full range of products currently manufactured at Trostre and, if Trostre cannot offer them, contracts are likely to be switched to another supplier who can provide a full range. It would also mean the applicant would have to compete with its sister company TSN for the Protact market.

For these reasons, this NUS scenario is not considered realistic.

Scenario E: Outsource electroplating to a third party based outside the UK (and the EU)

This scenario involves the applicant outsourcing Cr(VI) electroplating to a third party based outside the UK (and inevitably also the EU) where chromium trioxide is not regulated as it is under REACH. The pre- and post-electroplating steps could continue at Trostre, whereas the third party would be responsible for the Cr(VI) electroplating aspects.

This scenario is considered unrealistic for the following reasons:

- Given the high level of plant integration, it would be technically very challenging to simply remove electroplating from the overall ECCS production process and would lead to upstream stoppages (see Scenario A).
- The very high production volume (of around [redacted]) of ECCS means it is unlikely there would be any service provider immediately available and capable of meeting the applicant's needs. Existing non-UK and non-EU packaging steel producers are likely to have order books that are already sufficiently full to mean they would not be able to increase production volumes to the extent necessary (they, like the applicant, are likely to be integrated steelmakers).

- It would take many years for any third party to build a new plant, or build a new line at an existing plant, to deliver the required production volumes.
- As a result, it would likely be necessary to identify and qualify a number of third party provides to be able to deliver the quantities required.
- From a practical perspective, the transport costs and logistics associated with the use of even one third party, let alone several, would be prohibitive. It is likely that damage rates and waste would increase significantly.
- In addition, any third party would likely be a competitor of the applicant and so it would not be commercially desirable to place the work with them.
- From a quality and safety perspective, the applicant's customers expect a high level of integration. The products made at Trostre are used, to a large extent, for food packaging, which is highly regulated to ensure it is safe for food contact and does not pose health risks. Outsourcing introduces quality and compliance risks that are likely to be perceived as a retrograde step by the applicant's customers. These risks would be increased if several third parties were used, as it would be very difficult, if not impossible, to trace individual packaging items back to source if issues were identified (or to manage effective product recalls). Maintaining the site's AA+ rating against the BRCGS Global Standard for Packaging Materials is particularly important in this context (this demonstrates the site is providing products that are quality assured, legally compliant and authentic).
- The increase to the cost of goods sold (COGS) due to transport, logistics, third party charges, quality issues and so on would result in a higher product cost which would make the applicant uncompetitive and would therefore significantly affect market share.
- In addition, it would not be possible to implement this NUS immediately. Identifying, contracting with and qualifying a third party would take time, likely up to a year, during which time no revenue or profit would be generated from ECCS products.

Scenario F: Outsource electroplating to a third party based in the UK (or the EU)

This scenario is similar to Scenario E above but involves the use of a third party based in the UK (or the EU) who already holds an authorisation for the use of chromium trioxide to manufacture ECCS. However, this scenario is considered unrealistic for the following reasons:

- The applicant is not aware of any UK-based business that holds a relevant authorisation, or is currently in the process of applying for an authorisation, covering the applicant's use.
- There are EU-based businesses that hold a downstream user authorisation covering the applicant's use. These include TSN, whose authorisation the applicant was a part of prior to the UK's exit from the EU. However, it is unlikely such businesses could accommodate the demand from the applicant (and it would most likely take them over their authorised annual tonnage limits).
- It is possible that an upstream authorisation could cover an EU-based ECCS producer. Most relevant in this context is use no. 12 of the CTACSub2 application led by Chemservice GmbH (submitted in February 2024) which covers the use of chromium trioxide in electroplating for food packaging applications, amongst other uses, although the applicant could not benefit from that upstream authorisation as they are not named in it as being covered.
- However, even if UK or EU-based businesses had their own authorisations that could cover the applicant's use, outsourcing still brings with it all the issues discussed in Scenario E above, i.e. very significant quality, safety, commercial and practical obstacles.

In any case, most EU-based businesses with a relevant authorisation for the use of chromium trioxide are not likely to renew their authorisations on expiry of the review period. This is because the European Commission plans to move chromium trioxide away from authorisation requirements (Annex XIV of EU REACH) to restriction (Annex XVII of EU REACH), a move which is not currently being considered under UK REACH. Any existing EU REACH authorisation relevant to the applicant's use will therefore unlikely be of sufficient duration given the duration of the applicant's substitution plan.

Scenario G: Relocation of electroplating facility

This scenario considers relocating the electroplating facility (or indeed the entire ECCS production line) to a Tata Steel facility outside the UK (and the EU) where the use of chromium trioxide is not regulated as it is under REACH. Given that Tata Steel's operations span multiple regions worldwide, this scenario was considered but ultimately considered unrealistic for the following reasons:

- Politically such a move would be difficult, especially in the context of the forthcoming EAF project, including the £500 million GFA agreed with the UK Government.
- The scenario would require a new facility, or a new production line within an existing facility. This would take many years to implement, during which time there would be no revenue or profit generated from ECCS products.
- During this period of downtime, existing customers would be forced to source products from elsewhere. When production resumes, a significant loss of market share can be expected which would be very difficult to recover.
- Even on resumption of production, electroplating outside the UK and EU would bring with it transport and logistics issues that would be prohibitive, given the quantities of raw materials and finished products concerned and their weight.
- Any such move would require significant capital expenditure which is not guaranteed, especially in light of the increased transport and logistics costs.
- More generally, it makes little commercial sense in the steelmaking industry to manufacture in one territory for supply into another. Steel companies invest in a particular territory to sell into that market, not another. The applicant's ECCS output primarily serves the UK market. Offshoring production for the UK market would add at least another £150/tonne to the cost of its products. If the applicant were to relocate, it would be offshoring production for offshore markets, not the UK market.

Scenario H: Stockpiling

This scenario involves attempting to build up sufficient backstock of products that have been electroplated using chromium trioxide while an alternative is developed. This scenario was quickly ruled out as unrealistic as it would not be possible – the Trostre Works ECCS line is already at capacity with no headroom for the increase in production that this scenario would necessitate. It would also not be possible within the confines of the applicant's existing authorisation, which permits a maximum of 137 tonnes of chromium trioxide per year.

Scenario I: Use a supplier with an upstream authorisation that covers the use

This scenario involves moving from a downstream user authorisation held by the applicant to an upstream authorisation, e.g. an authorisation held by a supplier of chromium trioxide. This scenario was also quickly ruled out as the applicant is not aware of any existing authorisation for chromium trioxide under UK REACH that covers their use. Similarly, the applicant is not aware of any new or review report applications currently in process that cover their use. Even if there were, it is reasonable to speculate that an upstream authorisation application would be refused for similar reasons as any refusal to grant the applicant its review report authorisation application.

5.3.2 Conclusion on the most likely non-use scenario

Scenario B (total site closure) was selected on the basis that it is the only credible option. All other scenarios can be ruled out as unrealistic. Should an authorisation not be granted, the applicant would immediately be forced to cease the production of ECCS, which would in turn lead to ceasing ETP manufacture, and then to permanent site closure. The impact of a refused authorisation would travel far beyond the Trostre Works, with significant impacts on customers reliant on the applicant's packaging steel products. It would also undermine and destabilise the £1.25 billion EAF business model and the move to green steelmaking.

5.4 Societal costs associated with non-use

This section assesses the socio-economic impacts associated with non-use, in light of the selected NUS, to enable those to be compared to the applied for use scenario. This difference between the applied for use scenario and the most likely non-use scenario can be seen as equivalent to the benefits of granting an authorisation.

Based on the assessment of non-use scenarios, it has been shown that NUS Scenario B is the most likely scenario to be implemented in case an authorisation is refused, which provides the basis of the assessment. Economic impacts are considered from the point at which a refused decision takes effect, assumed for the purpose of this assessment to be 1st January 2028, i.e. end of the current review period, and are discounted to the base year 2025 (date of application for authorisation). EBITDA (Earnings before Interest, Taxes, Depreciation, and Amortisation) is used as a financial indicator for profits, where relevant. A 4% discount rate is used, in line with ECHA guidance.

5.4.1 Economic impacts on the applicant

Economic impacts of a refused authorisation have been evaluated where possible with reference to ECHA's guidance on assessing changes in producer surplus.[30] It aims to assess the net effect of a refused versus granted authorisation considering that losses or gains at the applicant may be partially or wholly offset by corresponding losses or gains by, for example, competitors. The aim is thus to disregard impacts that may be offset elsewhere in society from the assessment.

In the NUS, i.e. if the authorisation is not granted, the Trostre Works would close permanently, losing the future forecast profitability of the plant. Forecast profits are detailed in the table below, over the requested 15 year review period, and represent foregone profits (in terms of loss of EBITDA) from the date of a refused authorisation, assumed to be from 1 January 2028, i.e. immediately following the end of the current review period.

FY	25/26	26/27	27/28	28/29	29/30	30/31	31/32	32/33	33/34
Forecast EBITDA (£, m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Public range (£, m)	30 - 60	30 - 60	30 - 60	20 - 50	20 - 50	20 - 50	20 - 50	20 - 50	20 - 50
FY	**34/35**	**35/36**	**36/37**	**37/38**	**38/39**	**39/40**	**40/41**	**41/42**	**42/43**
Forecast EBITDA (£, m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Public range (£, m)	20 - 50	20 - 50	20 - 50	20 - 50	20 - 50	20 - 50	20 - 50	20 - 50	20 - 50

Table 28: *Forecast EBITDA over the requested review period*

ECHA's guidance recommends a period of 4 years of profit losses should be used for assessing producer surplus losses when suitable alternatives are not generally available (no-SAGA). The AoA demonstrates that there is no suitable alternative generally available to the applicant and so the use of the no-SAGA approach is appropriate here. However, the guidance also sets out a number of criteria which may justify extending this default period based on case-specific factors, as follows, and which the applicant believes apply in their circumstances:

[30] ECHA, 2021 (b).

- **Competition**: Producing ECCS requires substantial capital investment in specialised equipment, such as electrolytic coating lines, rolling mills and annealing furnaces. These facilities are not only expensive but also take considerable time to install and commission, and must be operated by highly skilled personnel. New entrants would also need to achieve regulatory compliance not only with the authorisation requirements under REACH but also legislation on major accident hazards (COMAH) and environmental permitting (EPR).

  The ECCS production process is also tightly integrated with both upstream steel supply and downstream packaging customers. Establishing reliable supply chains and building customer relationships takes time and trust, especially in a business-to-business market where packaging manufacturers rely on consistent quality and supply. Switching suppliers is not trivial due to qualification processes and food safety standards.

  While ECCS can also be imported from outside the UK, this route presents its own barriers. Importing involves longer lead times, higher transport costs and potential customs and border delays, particularly in the post-EU Exit context. These logistical challenges limit the flexibility of UK-based packaging manufacturers who often rely on just-in-time delivery.

- **Market share**: Given that the applicant holds approximately two-thirds of the UK market for ECCS and is the only domestic manufacturer, the market is not contestable in the short to medium term, and losses from closure of Trostre in the NUS would not be offset by gains to rival firms within the UK. If Trostre were forced to close, the UK market would lose its only domestic producer, and the entire volume the applicant currently supplies would need to be replaced by imports. Given the logistical challenges, potential supply chain disruptions and the time required for foreign producers to scale up capacity or reallocate supply, it is unlikely that this transition could happen smoothly or quickly. Moreover, imported ECCS may not be a perfect substitute in terms of lead times, flexibility or customer relationships, particularly for food packaging applications where quality and reliability are paramount.

- **Specialisation**: Although ECCS production methods are generally known within the industry and not heavily protected by patents, there are confidential aspects of the applicant's specific process that contribute to their competitive advantage. These aspects represent intangible assets that are difficult for competitors to replicate quickly or reliably.

  Just as important are the applicant's long-standing and close relationships with its customers. In the steel packaging sector, especially for food applications, customers place a high value on consistency, reliability and trust. These relationships are built over years through technical collaboration, product qualification and service responsiveness. If Trostre were to close, the applicant's customers would not simply switch to another supplier overnight. They would face disruption, requalification processes and uncertainty about whether alternative suppliers could meet their specific requirements.

- **Location**: The applicant's main competitors in the ECCS market are located outside the UK, primarily in continental Europe. Any gains they might make in the NUS, such as increased sales or market share, are not counted in the socio-economic analysis. This means that the losses to the UK economy in the event Trostre is forced to close would not be offset by gains elsewhere. The entire domestic supply of ECCS would be lost and the UK would become fully dependent on imports. These imports would only marginally contribute to UK employment and tax revenue, and would introduce additional risks such as supply chain disruption and loss of strategic capability in steel packaging.[31]

[31] House of Commons Library, 2025.

In such circumstances, the applicant considers a longer time period for producer surplus loss is appropriate and therefore will consider 5 years of profit losses in this assessment. These profit losses would commence on 1 January 2028, which is when the effects of a refused authorisation would commence, i.e. immediately following the end of the existing review period.

With reference to Table 28 above, forecast profits for 5 years from financial year 2028/29 total [redacted] million. Applying a standard social discount rate of 4%, this results in a profit loss of [redacted] million (public range £75 million to £200 million).

ECHA guidance also notes that any residual values from the sale or scrappage of tangible or intangible assets should be deducted from the calculated profit losses. The Trostre Works is a highly specialised facility producing up to 400,000 tonnes per year of tin-coated, chromium-coated and polymer-coated steels for packaging. The plant has numerous certifications and has undergone significant upgrades in its history, including energy efficiency improvements and waste recovery systems. However, in the event of sale or scrappage, it is expected that the plant and its inventory would only generate a relatively low sale value, as the plant was designed for the specific needs of the applicant. The plant's specialisation and integration mean that many assets may not easily be repurposed by other companies. It may be possible to sell some equipment which will have a certain market value, particularly standard items like motors, pumps or drives. However, the resale value of such equipment is difficult to predict reliably as it depends on age, condition and market demand.

Conversely, if the authorisation is not granted to the applicant, there will be high decommissioning costs associated with ceasing production at Trostre. For a facility like Trostre, these costs would include:

- Dismantling and removal of production equipment
- Demolition of buildings and infrastructure
- Utility disconnection and removal of site inventories of hazardous substances
- Environmental remediation
- Waste disposal and recycling
- Regulatory consents, including planning permissions and environmental permit surrender
- Contractual/commercial obligations, e.g. costs associated with termination clauses
- Monitoring and compliance reporting

The applicant has not attempted to monetise either the residual values from sale/scrappage of assets or the decommissioning costs as these are difficult to characterise reliably. However, the residual value of assets is expected to be low, whereas the decommissioning costs are expected to be high, meaning that the net effect could be negative. If so, this would add to, rather than detract from, the economic impacts faced by the applicant in the NUS.

This effect could be reduced if it was subsequently possible to sell the Trostre site, especially for residential construction. It is possible that Trostre's location may be seen as attractive for redevelopment, particularly given its proximity to major roads, existing infrastructure and commercial amenities. However, large industrial sites like Trostre face substantial barriers to redevelopment. Regeneration of former industrial areas in the UK is often constrained by land contamination from historical industrial activity, complex remediation requirements, weak local economies and labour markets, and planning and infrastructure constraints.[32] The applicant is also the major employer in the region and a key economic anchor for Llanelli. Without the applicant's presence, the attractiveness of local development would diminish. In addition, selling the site for residential development may not be practicable because this typically requires the highest standard of environmental remediation. Moreover, selling the site for commercial and/or industrial development may not be feasible because the site is already surrounded by a number of commercial and industrial parks.

[32] House of Lords Library, 2024.

Due to the high uncertainties, no further adjustments are made to the calculated profit losses described above.

5.4.2 Economic impacts on the supply chain

5.4.2.1 Impacts on the applicant's suppliers

The applicant purchases materials such as chemicals, fuels, bulk gases, machinery spares, consumables, utilities such as heating and electricity, and services such as logistics, maintenance, external security and other services from several suppliers. Most of these materials and services that are needed to manufacture the applicant's products are purchased within the UK from a multitude of (often local) companies.

The table below describes the applicant's average annual spend on materials and services using information from the previous five financial years.

Spend category (£, m)	FY21	FY22	FY23	FY24	FY25	Average
Chromium trioxide cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Operating supplies	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Carriage and shipping charges	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Electricity	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Bulk gases	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Water	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Fuel oil	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Hire of plant and equipment (without personnel)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Hire of plant and equipment (with personnel)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Hire of personnel	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Totals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Public ranges	**30 - 50**	**40 - 60**	**70 - 90**	**70 - 90**	**50 - 70**	**50 - 70**

Table 29: *Spending by the applicant on materials and services*

In addition, the table below describes the current annual values of service contracts between the applicant and various service providers.

Area	Contractor	Activity	Annual contract cost (£, m)	Headcount
Maintenance	[redacted]	Mechanical	[redacted]	[redacted]
		Electrical	[redacted]	[redacted]
		Civils	[redacted]	[redacted]
		Anode cast house	[redacted]	[redacted]
		Lubrication & Volk driver	[redacted]	[redacted]
	[redacted]	Scaffolding	[redacted]	[redacted]
Hires and leasing	[redacted]	Effluent plant costs, contract waste charges, steam costs, capital costs	[redacted]	[redacted]

Area	Contractor	Activity	Annual contract cost (£, m)	Headcount
	[redacted]	Scrap management, FLT hire	[redacted]	[redacted]
	[redacted]	Stores	[redacted]	[redacted]
		Cleaning	[redacted]	[redacted]
		Packing	[redacted]	[redacted]
	[redacted]	Site security	[redacted]	[redacted]
Totals			[redacted] **(Public range: 5 – 15)**	[redacted] **Public range: > 150)**

***Table 30**: Contract values between the applicant and its service providers*

In the NUS, i.e. the closure of the Trostre site, such spending would cease and therefore the applicant's suppliers of materials and services would no longer realise those revenues. The most significant socio-economic impacts from a non-granted authorisation will be suffered by those small and medium size UK companies that currently supply large amounts of raw materials or services exclusively or mainly to the applicant. For these suppliers, at a minimum, some downsizing or, in the worst cases, closure can be expected.

Some other (often larger) UK suppliers, even if they do not rely just on the applicant's purchases, might potentially face reduced sales, profit losses and negative social impacts in terms of job losses. Conversely, for companies for which the applicant's business represents a minimal part of their revenues would only be temporally impacted until they find other customers.

As a consequence, there will be significant impacts on many of the applicant's suppliers leading to additional profit and job losses in the supply chain. The applicant has no information about the profits generated by its suppliers as a result of its spending on the materials and services outlined in the tables above, nor can it reliably predict how its suppliers might react to the loss of revenue in terms of downsizing or job losses.

In the absence of detailed financial data from each supplier, the applicant has instead applied a conservative average profit margin of 5% to its total annual spend on goods and services to estimate the producer surplus loss across its suppliers. A 5% profit margin is used as this is a suitably conservative assumption, which helps avoid overstating the impacts while still capturing meaningful economic loss.

The applicant's average annual spend on materials and services is [redacted] (public range £50 million to £70 million) and the current annual service contract costs are [redacted] (public range £5 million to £15 million). Applying a 5% margin would suggest a [redacted] (public range £2.75 million to £4.25 million) annual producer surplus loss across its suppliers. Over a 5-year no-SAGA period, and applying a standard social discount rate of 4%, this would amount to [redacted] (public range £10 million to £16 million).

The estimated loss does not account for costs to the applicant associated with contract termination nor additional impacts on suppliers such as job losses, business closures or secondary economic effects, which are likely to be significant for high-dependence suppliers.

5.4.2.2 Impacts on the applicant's customers

The closure of the Trostre Works would have significant and far-reaching consequences for the applicant's customers who rely on the site's production of ECCS, Protact and ETP steel packaging products. As the only domestic manufacturer of these products in the UK, and with around 75% market share, Trostre plays a critical role in ensuring the availability of high-quality steel packaging materials for a wide range of applications, particularly in the food and beverage sector.

Many of the applicant's customers are highly dependent on the site's ability to supply consistent, reliable and compliant products. These customers have developed long-standing relationships with the applicant, built on trust, technical collaboration and supply chain integration. The sudden loss of this domestic supply would disrupt their operations, leading to delays, increased costs and the need to requalify alternative materials or suppliers. This is especially problematic in sectors like food packaging, where regulatory compliance, hygiene standards and product quality are paramount.

For UK-based customers, the loss of domestic supply would likely result in increased reliance on imports, which introduces logistical challenges, longer lead times and reduced flexibility. These changes could lead to production bottlenecks, missed delivery schedules and reputational damage. For some customers, particularly those with limited access to alternative suppliers or specialised requirements, the impact could be severe, potentially requiring changes to product design, packaging formats or even market strategy. International customers may also be affected, especially those who value the quality and consistency of Trostre's products and have built their supply chains around its output. While they may have access to other suppliers, the transition would not be seamless and could involve significant costs and operational risks.

In summary, the closure of Trostre would not only affect the site itself and its employees, but also ripple outward to its customer base, many of whom would face disruption, increased costs and strategic uncertainty. These impacts are not considered in the quantitative impact calculations as the scale and term of the effect are difficult to reliably characterise. Nevertheless, the impacts are real and material, and therefore should be considered as part of the broader socio-economic consequences of a non-use scenario.

5.4.3 Economic impacts on competitors

In case of a refused authorisation, the applicant would be forced to cease manufacturing at Trostre. As the demand for steel packaging would continue, it is expected that existing and new competitors with an established manufacturing base outside the UK would take over the position in the market left by the applicant. The economic impact on competitors is therefore likely to be positive, approximately equal to the value of the lost sales suffered by the applicant.

This means that electroplating activities using chromium trioxide would transfer from one party to another. Considering the current location of competitors, the status of individual competitors with regard to the absence of regulatory requirements outside the EU or existing approvals to carry on using chromium trioxide for electroplating inside the EU (both in terms of existing authorisations and the ability to meet the conditions of the forthcoming EU REACH Cr(VI) restriction), and the absence of regulatory restrictions relating to the import of ECCS manufactured using chromium trioxide into the UK, it is expected that all activities would transfer from the UK to suppliers outside the UK. There would be an associated transfer of economic activity, including profit, and (importantly) risk to human health associated with these activities from the UK to the countries in which the new suppliers are based.

This represents a clear transfer of costs from the UK to the EU and beyond. The economic value associated with domestic production, including revenues, employment, investment and supply chain activity, would be lost to the UK and gained by non-UK producers. While the lost revenues and profits to the applicant and its supply chain have been accounted for elsewhere in this SEA, this transfer of costs highlights the broader societal impact of the authorisation decision. It reflects a redistribution of economic activity across borders, rather than a net loss or gain to society as a whole, and underscores the strategic implications of losing domestic capacity in critical packaging materials.

5.4.4 Wider socio-economic impacts

5.4.4.1 Impacts to workers

The closure of Trostre foreseen in the NUS would mean the permanent loss of [redacted] workers (public range: > 600) currently employed by the applicant at the site. This figure does not include the applicant's employees who work at other locations but whose jobs are reliant, in whole or part, on Trostre operations, nor approximately [redacted] permanent contractors at the site.

ECHA[33] and Dubourg[34] set out an approach to valuing the social costs from job losses considering:

- the value of lost output/wages during the period of unemployment
- the cost of acquiring a new job
- recruitment and training costs
- scarring costs relating to compulsory redundancy
- the value of leisure time during the period of unemployment

The ECHA approach and associated data from the Dubourg report values the social costs at 1.88 times the annual gross wage including employer taxes and 2.09 times the gross annual salary excluding employer taxes of each worker in the UK. This is lower than the value of 2.7 recommended by ECHA and can therefore be considered conservative.

The unemployment figure associated with a refused authorisation is [redacted] (public range: > 600). This value has been used in the assessment of social costs. Trostre salary data from the 2024/2025 financial year is used to calculate the social impacts of unemployment in the NUS. Although jobs would be lost from the date of a refused authorisation, assumed to be 1 January 2028 for these purposes, the salary data have not been adjusted for inflation from the 2025 base year.

	Cost per worker £ [1]	Net number of workers not employed in NUS	Total cost £ [2]
Social cost of unemployment	[redacted]	[redacted]	[redacted]
Public range	80,000 – 120,000	> 600	50,000,000 to 75,000,000
Notes: 1 = Average annual salary of [redacted], multiplied by the Dubourg figure of 1.88 to give the cost per worker. 2 = Cost per worker multiplied by the number of workers.			

***Table 31**: Social impacts of lost employment opportunity in the NUS.*

The social cost of unemployment is therefore valued at [redacted] (public range £50,000,000 to £75,000,000) in the base year.

5.4.4.2 Other impacts

The closure of the Trostre Works would have very significant social consequences for Llanelli and the wider South Wales region. As the largest employer in Llanelli and a cornerstone of the local economy, Trostre is not only a source of income for hundreds of families but also a symbol of the town's industrial heritage and identity. Its loss would represent more than just job displacement – it would erode the social fabric of a community historically built around steelmaking. The ripple effects would extend to local businesses, schools and public services, all of which are sustained in part by the economic activity generated by Trostre and its workforce.

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[33] ECHA, 2016 (c).

[34] Dubourg, 2016.

Figure 40*: Image from the Tin Works exhibition at the National Museum of Wales (Swansea Waterfront) featuring a display of 146 employee and contractor portraits on tinplate, a project by artist Hilary Powell, as part of the site's 70th-anniversary celebrations in 2022.*

There would also be significant impacts on the applicant's integrated operations and workforce. The applicant operates a highly integrated network of production sites, with Trostre playing a critical role in the downstream processing of HRC into high-value ECCS, Protact and ETP products. The closure of Trostre would disrupt this integration, undermining the operational and financial viability of other sites such as Port Talbot, Shotton, Hartlepool, Corby and Newport. The applicant's sites are interdependent, and the loss of one node in the network, particularly one as strategically important as Trostre, would destabilise the entire system. This could lead to further job losses, reduced investment and diminished competitiveness across the applicant's operations, compounding the social impact well beyond Llanelli.

Prior to the closure of its blast furnaces, Port Talbot supplied Trostre with HRC produced domestically. During the transition period while the new EAF is being constructed, Trostre has had to source HRC from various non-UK suppliers. When the Port Talbot EAF becomes operational, domestic supply is anticipated to resume [redacted]. The EAF facility is designed to produce [redacted] (public range: up to 3.2 Mt/year). Trostre has the potential to consume [redacted] (public range: up to 500 kt/year) of that output through its manufacture of ECCS, Protact and ETP. If Trostre were to close, Port Talbot would therefore face an overcapacity of [redacted] (public range: up to 500 kt/year) of HRC relative to the existing downstream configuration. The applicant would be forced either to reduce production or sell the excess as a lower-value commodity, resulting in foregone added value. The resulting loss could be up to [redacted] (public range: up to £250 million per year) at typical differentials, and may be higher once second-order effects such as further reductions in HRC price due to excess market availability are taken into account.

[redacted]

[redacted]

[redacted] the scale and duration of these impacts cannot be quantified with confidence. For this reason, they are not included in the numerical impact calculations presented in this assessment.

However, this [redacted] does not diminish the magnitude of the socio-economic impacts arising from a closure of Trostre. [redacted] Trostre's closure would remove a significant revenue and margin contribution from the UK business. Many functional fixed costs would have to be funded from a reduced revenue base, effectively increasing overhead rates for remaining assets. That dynamic would erode the economics of the wider portfolio and undermine the financial model underpinning the applicant's £1.25 billion EAF investment at Port Talbot, one of the most significant industrial decarbonisation initiatives underway in the UK and supported by a £500 million Grant Funding Agreement with the UK Government.

In addition to these direct commercial effects, closure of Trostre would have wider repercussions. It would result in the permanent loss of skilled employment and specialist know-how embedded at Trostre, put at risk over 5,000 permanent jobs reliant on the success of the Port Talbot transition, disrupt established supply relationships with food packaging manufacturers, and reduce UK self-sufficiency in packaging steels. It would weaken the strategic rationale for domestic production of critical materials aligned to the UK's decarbonisation and circular economy goals, and it would undermine investor confidence in long-duration transition investments such as the Port Talbot EAF project. Taken together, these impacts are substantial and long-lasting.

5.4.5 Compilation of socio-economic impacts

The socio-economic impacts that are expected from a refused authorisation for chromium trioxide, taking effect from the start of 2028 (compared to the situation of continuing the use of the substance) are summarised in Table 32 below. This presents the findings considering a 5-year (no-SAGA) horizon for economic impacts for the applicant to 2033.

Description of major impacts	Monetised / quantitatively assessed / qualitatively assessed impacts	
1. Monetised impacts	**£ [per year]** [1]	**£ [Over 5-year no-SAGA period]**
Economic impacts on the applicant	[redacted] Public range: £15 million to £40 million	[redacted] Public range: £75 million to £200 million
Economic impacts on the supply chain	[redacted] Public range: £2 million to £3.2 million	[redacted] Public range: £10 million to £16 million
Economic impacts on competitors	Not quantified	
Social cost of unemployment	[redacted] Public range: £10 million to £15 million	[redacted] Public range: £50 million to £75 million
Sum of monetised impacts	[redacted] Public range: £27 million to £58.2 million	[redacted] Public range: £135 million to £291 million

Description of major impacts	Monetised / quantitatively assessed / qualitatively assessed impacts
2. Additional quantitatively assessed impacts	
N/A	Not considered in this assessment
3. Additional qualitatively assessed impacts	
Wider socio-economic impacts	Very significant, but not possible to quantify reliably (See sections 5.4.2.2 and 5.4.4.2 for details)
Notes: 1. Per average year during the time horizon used in the analysis	

***Table 32**: Socio-economic costs associated with non-use.*

5.5 Combined impact assessment

The different impacts that are expected from non-authorisation of the use applied for can be compared to the remaining risks associated with the continued use of chromium trioxide. The findings are summarised in the table below, as relevant.

Societal costs of non-use		Risks of continued use	
Monetised impacts (£)	[redacted] per year Public range: 27,000,000 to 58,200,000 per year [redacted] over 5 years Public range: 135,000,000 to 291,000,000 over 5 years	Monetised excess risks to directly and indirectly exposed workers (£)	1,561 to 2,616 per year 23,421 to 39,233 over requested review period
Additional quantitatively assessed impacts	-	Monetised excess risks to the general population (£)	84,282 to 144,239 per year 1,264,229 to 2,163,587 over requested review period
Qualitatively assessed impacts	See section 5.4	Qualitatively assessed risks	-
Summary of societal costs of non-use (£)	[redacted] **per year** **Public range: 27,000,000 to 58,200,000 per year** [redacted] **over 5 years** **Public range: 135,000,000 to 291,000,000 over 5 years**	**Summary of risks of continued use (£)**	**85,843 to 146,855 per year** **1,287,650 to 2,202,820 over requested review period**

***Table 33**: Societal costs of non-use and risks of continued use*

The aggregated societal benefits of the continued use of chromium trioxide for the manufacture of ECCS are expected to be [redacted] (public range: £135 million to £291 million) over the period, whereas the aggregated monetised health impacts of the use applied for are expected to be between £1.29 million to £2.20 million (lower and upper bounds over the review period requested by the applicant). Therefore, over the 15 years, the benefits outweigh the risks by a factor of [redacted] (public range: > 60). This is a very conservative estimate taking into account the lower values for the negative impacts and the higher bound for the human health impacts.

5.6 Sensitivity analysis

The ECHA guidance on SEA[35] proposes an approach to conduct an uncertainty analysis. This approach provides three levels of assessment of uncertainties: qualitative, deterministic and probabilistic. The ECHA Guidance further indicates that the level of detail and dedicated resources to the assessment of uncertainties should be proportionate to the scope of the SEA.

As the socio-economic impacts for the uses applied for outweigh the (worst-case) health impacts of the continued use by a very large factor, performing a systematic (but qualitative) analysis of uncertainties is sufficient. This analysis of the key parameters that might potentially challenge the quantitative results of the SEA and of the human health assessment helps to determine the key uncertainties, their level of magnitude (low, medium, high) as well as their direction (under- or over-estimation).

Where there is variability in the quality of the available input data, given the associated uncertainties, the applicant has sought to apply a conservative approach by overestimating human health impacts of the continued use scenario and by underestimating the socio-economic impacts of the non-use scenario.

	Details	Level of uncertainty (L/M/H)	Direction of the uncertainties (Underestimation and overestimation)
Human health impacts	Reference-dose response relationship for carcinogenicity of Cr(VI)	Medium	The reference dose response relationship for carcinogenicity of hexavalent chromium, including the assumption of linearity at low dose, is likely to overestimate human health risk.
	Exposure levels – workers	Low	Personal sampling results have been increased to reflect the potential exposure over a 12 hour shift. This is likely to overstate the actual exposure because activities liable to result in Cr(VI) exposure only occur for a relatively short period of time across a shift and are already likely accounted for in the measured data, i.e. increasing the filter concentration is not likely to be a true reflection of potential additional exposure over the unmonitored remainder of the shift.
	Exposure levels – general population	High	The assumption of 100m distance for the entire number of people in the vicinity of the plant likely represents an overestimation of the impact.
	Exposure levels – general population	High	Stack emissions measurements used in the assessment are for total Cr, not Cr(VI), which will overstate the presence of Cr(VI) in emissions to atmosphere from the site.
	Number of people exposed at local level	Medium	Potential for underestimation of the number of people exposed (general population) by not using default value of 10,000. Instead, 3,822 people assumed to be present within 1km radius of emission point.
	VSL and VCM values	Low	Uncertainty in and relevance of the values of a statistical life (VSL) and morbidity due to cancer (VCM) published by ECHA.

[35] ECHA, 2011.

	Details	Level of uncertainty (L/M/H)	Direction of the uncertainties (Underestimation and overestimation)
Socio-economic impacts	Quantities used	Low	Annual tonnage quoted likely to exceed actual quantities used
	Forecast revenue and profit data for the applicant	Low	Actual revenue and profit realised may not be the same as forecast revenue and profit data. Nevertheless, revenue and profit forecasts are considered reliable and small variations are unlikely to significantly affect the overall assessment.
	Foregone profits	Medium	The baseline for the assessment considers foregone profits over a 5-year period, compared with health costs over the requested review period of 15 years (from 2028). The estimated foregone profits to 2043 are therefore provided for context and comparison. In both cases, economic costs are far greater than health costs, where both are estimated conservatively, meaning health costs are over-estimated and economic costs are under-estimated.
Substitution plan	Substitution plan timelines	Medium	Uncertainties described in section 4.3.2. Timelines have attempted to establish a suitable balance between 'best-case' and 'worst-case' scenarios

***Table 34**: Uncertainties regarding human health impacts and socio-economic impacts*

5.7 Information to support the review period

A review period of 15 years is requested for the use of chromium trioxide for the manufacture of ECCS. The evidence presented in this combined AoA-SP-SEA report supports such a review period as it demonstrates that:

- There are currently no suitable alternatives generally available (SAGA) to the use of chromium trioxide to manufacture ECCS that meet the applicant's key functionalities. Like many others, the applicant has been seeking viable alternatives to Cr(VI)-based electroplating for some time and has expended significant resources to that goal, working in collaboration with others in their sector. So far, no alternative has been identified that provides the same performance levels and there is no clear prospect of their deficiencies being addressed in the foreseeable future, a situation which is unlikely to change in the next decade.

- The majority of the applicant's products are used by the food and drink sector, which is highly regulated. The applicant must consider very carefully any changes to the current composition and manufacturing processes for its products, as these must be assessed for their potential impact on food safety and quality.

- The applicant will have to perform many complex, resource- and time-consuming tasks in order to successfully substitute its manufacturing process to transition to a Cr(VI)-free alternative. The identification, development, scale-up and industrialisation of potential alternatives is a long-term project. The substitution plan demonstrates that it is likely to take over 15 years, as a balance between the best-case and worst-case scenarios, and highlights the various complexities and challenges that may be faced.

- The applicant's competitors will also supply ECCS manufactured using chromium trioxide and which are available for import from the EU (under existing authorisations and, in the future, in compliance with the conditions of the forthcoming Cr(VI) EU REACH restriction) or the rest of the world (where the use of chromium trioxide is not subject to comparable regulatory controls). This means that the use of chromium trioxide to produce ECCS will continue in the EU and the rest of the world throughout the entirety of the review period requested by the applicant, and beyond.

- Health risks for workers from the use of chromium trioxide are kept at a minimum as the production processes at the applicants' sites are highly automated, a range of engineering controls are employed and directly exposed workers wear appropriate PPE (see Chemical Safety Report).

- The applicant's wastewater treatment and air abatement systems are able to minimise the amount of Cr(VI) reaching the environment that might represent a potential exposure risk for the general population.

- Finished products do not contain any Cr(VI) and are not harmful to end users nor to the environment.

- In this AfA, the risks of using chromium trioxide have been deliberately overstated, whereas the benefits have been deliberately understated. Using this approach, the monetised costs to human health from continued use of chromium trioxide are estimated to be between £1.29 million to £2.20 million (lower and upper bounds over the review period requested by the applicant). On the other hand, the aggregated societal benefits of continued use of chromium trioxide for the production of ECCS are expected to be [redacted] (public range: £135 million to £291 million) over a 5-year no-SAGA period. This means the risks of continued use are 'low' and, by comparison, the socio-economic benefits are 'high', a situation which is unlikely to change in the next decade. The application therefore meets the criteria for a 'long' review period, as per RAC/SEAC guidance.

If an authorisation is granted, the applicant will continue in its efforts to identify and develop alternatives which have comparable performance to Cr(VI)-based electroplating. R&D efforts are underway although are not expected to lead to the development of suitable alternatives that could become available in a shorter review period than that requested. A range of substitution activities are set out in the Substitution Plan which forms part of this AfA, together with a suggested timeline and details of the steps involved and their associated complexity and uncertainties.

6. Conclusions

The applicant is the largest steel producer in the UK, with a network of manufacturing and distribution sites across the country. The company plays a key role in many of the UK's strategic supply chains, particularly in the automotive, construction, engineering and packaging sectors. It is recognised not only as a supplier of high-quality steel products but also as a trusted innovation partner to numerous leading brands.

The applicant's site in Llanelli, Carmarthenshire (the Trostre Works) is the sole producer of tinplate steel (ETP) and tin-free steel (ECCS) for packaging in the UK. The site, which celebrated its 70th year in 2022, manufactures up to 400,000 tonnes of tin, chromium and polymer coated steels every year. These materials are used in a wide range of packaging applications, including food and beverage cans, bakeware and other consumer goods. Trostre is widely regarded as a leading global supplier of high-quality packaging steels, with exports to over fifty countries.

The applicant uses chromium trioxide at the Trostre Works for the manufacture of ECCS. The substance is used to apply a thin layer of chromium (Cr(0)) and chromium oxide onto flat metal products (steel surfaces) by electrolytic deposition, with the electroplating performed in a highly automated way with a minimum of exposure and emissions. The resulting coating is free of chromium trioxide and in turn provides a surface for excellent adhesion for a subsequent functional organic coating (lacquer or laminate). The applicant's products are then used by their customers to produce food packaging (cans for food and drink) and various other types of metal packaging.

Chromium trioxide is listed in Annex XIV of REACH and is subject to authorisation. The applicant already has an authorisation under REACH for the use of chromium trioxide for the manufacture of ECCS (authorisation number UKREACH/22/02/0), with a review period ending on 31 December 2027.

Chromium trioxide plays a critical role in the production of ECCS – the structured layers of chromium metal and chromium oxide, together with the applied organic coating, provide a high and reliable standard of corrosion and chemical resistance during the lifecycle of the packaging material that cannot be achieved by other methods. This is particularly critical in food and beverage packaging, where material integrity and safety are paramount. The use of chromium trioxide offers several key benefits:

- It creates a highly corrosion- and chemical-resistant surface that protects the underlying steel from reacting with the contents of the packaging. Without this protection, there is a risk of contamination, which could compromise food safety and pose health risks to consumers.
- It significantly enhances the adhesion of the organic topcoat, which acts as an additional barrier between the steel and the packaged food. This dual-layer system ensures that the contents remain uncontaminated, preserving taste, texture, and nutritional value over extended shelf lives.
- It contributes to the mechanical strength and formability of the steel strip, which is essential during the can manufacturing process. This ensures structural integrity and prevents defects that could compromise the seal or performance of the final product and which could again result in contamination of the food or drink.

Since chromium trioxide became subject to authorisation under REACH, it has proven very challenging for industry to find a suitable alternative substance or process which provides the same multi-functionality of coatings generated from chromium trioxide. There is no viable alternative at the present time.

A wide range of potential alternatives to chromium trioxide were considered in the Analysis of Alternatives (AoA), drawing on the applicant's own R&D efforts, consultations with suppliers, relevant literature and other authorisation applications. Among these, Cr(III)-based alternatives were identified as the most promising and were shortlisted for detailed evaluation. However, Cr(III)-based alternatives, like all other options assessed, currently fail to meet the necessary performance criteria and are therefore not technically feasible. These coatings do not match the performance of chromium trioxide-based systems in terms of corrosion resistance, chemical stability, adhesion and compliance with food safety standards. They lack the durability required for long-term food contact applications and have not been fully validated for such use. Substituting chromium trioxide with these alternatives would increase the risk of can failure, reduce shelf life, and potentially compromise food safety.

ECCS is a strategically important product for the applicant, forming a core part of its packaging steel portfolio. The company has made substantial investments in the infrastructure and expertise required to produce high-quality ECCS, supporting both domestic manufacturing and international competitiveness. UK-based customers, including major can-makers and food producers, depend on a stable supply of ECCS to meet stringent food safety standards and ensure reliable product performance. The material's consistent mechanical properties and surface finish are essential for efficient can-making and long shelf-life preservation.

At the national level, ECCS production contributes significantly to the UK economy through employment, industrial output, and supply chain resilience. The importance of this activity was underscored during the COVID-19 pandemic, when packaging steel production for food applications was designated as essential by the UK Government. If authorisation is not granted, and ECCS production ceases, customers would be forced to source material from outside the UK. This would expose the UK food sector to supply chain vulnerabilities, increased costs and potential quality risks, while weakening domestic manufacturing capability.

The applicant has assessed what it would do in the event of a refused authorisation and concluded that, due to the technical infeasibility of alternatives, ECCS production would have to cease. Given the high level of integration at Trostre Works, this would also result in the cessation of electrolytic tinplate (ETP) production and therefore result in full site closure. The consequences would extend far beyond Trostre, affecting customers, suppliers and the applicant's broader operations, particularly the viability of the new £1.25 billion Electric Arc Furnace (EAF) facility at Port Talbot, supported by a £500 million Grant Funding Agreement with the UK Government. The loss of Trostre would destabilise the EAF business model, undermine the UK's green steel transition and jeopardise the competitiveness and profitability of future operations.

Given the aims of the SEA, the analysis purposefully sought to characterise certain impacts but also, where appropriate, to undervalue socio-economic impacts, and overvalue health impacts. This approach supports confidence in the findings of the assessment.

The aggregated societal benefits of the continued use of chromium trioxide are expected to be at least [redacted] (public range: £135 million to £291 million) over the period, whereas the aggregated monetised health impacts of the use applied for are expected to be between £1.29 million to £2.20 million (lower and upper bounds over the review period of 15 years requested by the applicant). Therefore, over the 15 years, the benefits outweigh the risks by a factor of [redacted] (public range: > 60). This means that the remaining risk of continued use is 'low' and the socio-economic benefits are 'high', a situation which is unlikely to change in the next decade.

Despite the current failings of potential alternatives, the applicant will continue to devote substantial time and resources to R&D into alternatives. Accordingly, a Substitution Plan has been included in this AfA which considers the steps proposed to switch to a Cr(VI)-free alternative in more detail. Substitution will be a complex, multi-phase process involving research, testing, validation and eventual industrialisation. Based on the applicant's experience, this pathway requires significant time, resources and investment, and is subject to many technical and regulatory challenges. Despite extensive efforts, no technically feasible alternatives currently exist, and there is no 'drop-in' substitute available. As such, the applicant anticipates that substitution will not be achievable before 2043 and requests a 15-year review period from the end of the current authorisation. This reflects the scale and uncertainty of the transition which, while actively pursued, remains a long-term endeavour with no guaranteed outcome.

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