Best Available Techniques
UK BAT

UK Best Available Techniques Kick-off Meeting Summary for the Surface Treatment of Metals and Plastics Sector

Kick-off meeting: 25-27 February 2025

Contents

Executive Summary

The Surface Treatment of Metals and Plastics (STM) Technical Working Group (TWG) have initiated the review of Best Available Techniques (BAT) in the UK with the aim of establishing BAT Conclusions (BATC) for the sector.

Comments from initial engagement concerning the scope and other elements of the review of BAT were discussed by the TWG at a kick-off meeting. The TWG discussions and subsequent consensus agreements are summarised in this document.

The TWG reviewed and agreed by consensus a detailed scope of the BAT review based on the appropriate UK regulations. This agreed scope expanded upon the Standards Council commission based on relevant activities within the Industrial Emissions Directive (IED). The full details of the scope are presented in Appendix 2.

The TWG also discussed and agreed further details of the BAT review including details of the basis through which the review will be undertaken, identifying the key environmental issues (KEIs). This identifies those environmental impacts which require the TWGs focus, such as emissions to water and air from STM activities and ensures that the review is specific to operations undertaken within the UK.

The techniques which enable emissions to be prevented or minimised were discussed and agreed in support of the collection of evidence. These techniques are relevant to the listed and directly associated activities based on the scope and KEIs. This will enable the TWG along with international benchmarking, to determine the BATC and BAT associated emission limit values (BAT-AELs) for permitted activities, within the scope of the review of BAT. The KEIs and techniques agreed for inclusion and exclusion are found in the appropriate sections of this paper.

The TWG agreed several actions which are recorded in Appendix 3 and confirmed that there were no other substantive issues requiring their discussion and agreement, before the collection of evidence by the TWG.

Overview

This paper summarises the main outputs and decisions made by the STM Technical Working Group (TWG) for the review of Best Available Techniques (BAT) in the STM sector at the kick-off meeting held 25th to 27th February 2025.

It begins with a short summary of the background and legal context to the UK process for reviewing BAT. It then summarises the TWGs agreed positions on the scope and other elements which establish the basis of the review.

This process forms an important part of the transparent approach which is aimed at ensuring the UK continues to be at the forefront of improving environmental performance, whilst supporting sustainable industry development.

Background and UK legal context

Best Available Techniques (BAT) are the economically and technically viable techniques which are the best for preventing or minimising emissions and impacts on the environment. Industrial installations undertaking specific types of activity are required to use BAT to reduce emissions to air, water and land.

The Environment and Wildlife (Legislative Functions) (EU Exit) Regulations 2019 defined in the European Union (Withdrawal) Act 2018 allows for an appropriate authority to specify BAT Conclusions for the purposes of provisions that have transposed Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions (integrated pollution prevention and control) into domestic law.

The development of future BATC separately from the EU will be based on the common origin of the legislation to ensure BAT continues to be based on the same principles. The definition of BAT in UK law remains unchanged following EU exit and it forms part of our retained EU law alongside all existing BATC that were developed at the EU level (largely on a sector-by-sector basis).

This function now rests independently with the UK Government, Scottish Government, Welsh Government, and the Department for Agriculture, Environment and Rural Affairs, Northern Ireland (DAERA) who have executive power to adopt BATC.

The BAT process will operate using a transparent, collaborative, flexible, data and evidence led process, that safeguards and builds on the high levels of environmental protection already in place across the UK.

Technical Working Groups (TWGs) are formed for each sector under review. They work in a collaborative forum to discuss and develop BAT Conclusions (BATC) for the sector in the United Kingdom. The BATC are based on the collected evidence for the sector and through benchmarking of the techniques and associated emission limit values (BAT-AELs) against internationally sourced evidence.

The BATC will comprise of a short description of each best available technique identified, its applicability and where appropriate, an associated emission, consumption or performance level.

A formal draft UK BATC will be published for comment and public consultation. When approved they will be published as a Statutory Instrument and used as a basis for setting environmental permit conditions.

Sector Overview

Metals and plastics can be treated to change their surface properties. For example, to provide decoration and reflectivity, improved hardness and wear resistance, corrosion resistance, or to provide a suitable base to improve adhesion of other treatments such as painting, enamelling, or photosensitive coatings for printing.

The UK STM sector provides a service to a wide range of other industries by improving the surface properties of materials through processes like coating, plating, and heat treatment. This can improve performance, longevity, durability, corrosion resistance, and wear resistance of products across industries such as automotive, aerospace, and manufacturing. The size of items treated ranges from nuts and bolts to large steel rolls of over 30 tonnes.

Treatment was defined in the Environment Agency Regulatory Guidance Note 2 (RGN2)[1] as follows: "Surface treating …using an electrolytic or chemical process" means treatment in which there is a chemical reaction at the surface and the surface is altered chemically. This aligns with the definition in the Surface Engineering Association permitting plan[2] that surface treatment causes a chemical change to the surface.

The item to be treated is usually referred to as the 'workpiece', and the material of the surface being treated is the 'substrate'. Typically, the surface treatment process involves immersion of the workpiece in and out of a sequence of vats in a line. Some vats contain chemicals and/or electric current, and some only contain water, to provide a rinse between treatments steps.

The surface treatment activity may be part of a larger manufacturing facility to provide treatment for the items made on site. Or it may be carried out by a separate company which offers a specialist treatment or range of treatments to customers for various items. The STM sector generally utilises various techniques on workpieces, beginning with pretreatment (e.g. degreasing), and followed by least one main process (e.g. electroplating or anodising). The workpiece is dried, before any further processing which may be needed.

Techniques to reduce the quantity of liquid from a vat being carried out with the workpiece ('drag-out') and to reduce the quantity of liquid being carried into a vat ('drag-in') are very important. This helps minimise rinse water consumption, contamination and wastewater generation, and minimise the consumption of treatment chemicals.

Pre-treatment of the workpiece surface is critical for the effective treatment of the surface for all processes. This might include mechanical polishing, grit blasting, blasting with CO_2 pellets, degreasing using solvents, and aqueous cleaning using alkalis or acids.

Post treatment processes include drying of the workpiece. This can be carried out by immersing the workpiece in hot water then allowing it to air dry, or by applying hot air. In some cases, a heat treatment for hydrogen de-embrittlement is carried out, or a coating is applied to the treated surface.

[1] The Surface Treatment of Metals and Plastics by Electrolytic and Chemical Processes (EPR 2.07): https://assets.publishing.service.gov.uk/media/5a7c5612ed915d3d0e87bb37/geho0209bpip-e-e.pdf. Accessed 17/11/25

[2] **Draft PPC Permitting Plan for the Surface Treatment Sector, Surface Engineering Association, 2003**

Conventionally, STM covers chemical and electroplating activities, and anodising. However, there are other STM subsectors carrying out specific types of surface treatment with similar processes that potentially will be included in this review. These are semiconductor manufacturing, printed circuit board manufacture, and vitreous enamelling.

Semiconductor manufacturing is a complex activity involving multiple processes to create multiple layers on the substrate surface. These include physical and chemical vapour deposition (PVD/CVD), atomic layer deposition (ALD), photoresist application and stripping, wet and dry etching, doping, layering, and mechanical polishing. Similar to other STM activities, some of these processes physically remove material from the substrate and others involve a chemical reaction, thereby changing the surface properties.

Vitreous enamelling is the process of coating a metal with a glass-like layer. Typically, the metal substrates used are cast iron, steel and aluminium, but vitreous enamelling can be applied to copper, silver, gold, glass and high temperature alloys. The activity steps include a pretreatment such as degreasing and/or pickling to clean the surface and to make the surface rough for enamel adherence. This is followed by application of frit either by dipping, spraying or brushing, and finally drying and firing of the product.

Printed circuit board (PCB) manufacturing involves construction of often complex electronic circuits printed onto thin, non-conductive layers, for the subsequent addition of electronic components. These might be resistors, capacitors, semi-conductors, mounts for processing chips, and memory chips. Generally, the substrates are phenolic paper, epoxy paper or epoxy glass laminates, and ceramic materials. Flexible or flex-rigid materials might also be used. Copper plating and electroplating of copper and other metals are both used in PCB manufacture. Metals other than copper may be occasionally used for specific applications, such as aerospace.

The sector has some key environmental considerations, such as emissions to water of hazardous or persistent chemicals, emissions to air from chemical processes or combustion processes, and generation and disposal of solid wastes and by-products.

Understanding the sectors' impact on climate change and the challenge of achieving Net Zero is a critical aspect of the BAT review. It is also important to understand the impacts of climate change on the sector and prevention of potential accidents due to more severe weather.

Regulated installations in the UK

There are currently estimated to be 123 permitted STM installations in the UK that will be affected by this review of BATC. An additional 14 sites permitted under Section 4.2 of the inorganic chemical regulations, which includes semiconductor sites, will also potentially will be included in the review. This number may change due to clarification of installation activities and whether they are within scope.

Initial engagement

The first stage of the STM BAT review was engagement with the public through a Citizen Space survey and via a detailed First Positions Industrial Questionnaire (FPIQ). The aim of this engagement was to seek feedback on the environmental impacts of the sector in the UK. This information was essential to support the development of appropriate BATC. Both methods of engagement focussed on 3 key themes to help begin the review of BAT. These were the scope of the review based on UK legislation, the key environmental issues for the sector, and the techniques which are used in the sector to prevent or where this is not possible, to minimise pollution. Both surveys were undertaken between 15 July 2024 and 7 October 2024.

The Citizen Space survey gathered views from 16 responses across a range of issues. Most responses agreed with the proposals regarding the scope and structure of the review being undertaken.

The industry specific questionnaire received 17 responses. Responses covered the full range of questions and proposals outlined in the survey. The respondents generally agreed the general scope and process for inclusion in the STM review. There were some differences in option about specific points within the Kick-Off meeting paper. These were discussed at the Kick-Off meeting in 23 - 25 February 2025 meeting in Sheffield.

Experts from industry, regulation, academia, and NGOs were invited to join the Technical Working Group (TWG) and were invited to the Kick-Off meeting. The anonymised responses were summarised and discussed by the TWG, at the appropriate parts of the Kick-Off meeting agenda. The responses and discussions formed an important part of the review. Detailed discussions by the TWG regarding the responses, are summarised in the relevant sections of this note. Where the discussions resulted in an action, the actions are logged in Appendix 4.

Scope of Review

The TWG discussed the scope of the BAT review for the sector. Discussions included reviewing the comments received from initial engagements with those directly involved in the sector and through the Citizen Space questionnaire.

The high-level scope comprises the following industry activities described in the Industrial Emissions Directive Annex I to Directive 2010/75/EU and are incorporated into UK Law:

2.6 Surface treatment of metals or plastic materials using an electrolytic or chemical process where the volume of the treatment vats exceeds 30m^3.

6.11 Independently operated treatment of waste water not covered by Directive 91/271/EEC, provided that the main pollutant load originates from the activities covered by these BATC.

The TWG identified the need for clarity in the scope, avoiding crossover with other BATC. Some specific processes were discussed such as pickling which has already been included in the Ferrous Metal Processing UK BATC.

The original interpretation of ‘treatment’ and the breadth of the scope was also discussed by the TWG. There was a difference in opinion about how broad the scope should be at this stage. The group considered if it should specify all processes that affect the base material, or if it should be agreed as surface treatment resulting from immersion in a solution. A comment was made that the interpretation of STM was originally defined for this sector in collaboration with the Environment Agency. It was agreed that the details about specific processes would be addressed, and these are covered in the next section.

It was clarified that offsite effluent treatment was not in scope of the review of BAT.

The IED based scope was agreed by the TWG as appropriate for the STM review.

Associated in scope activities not specified in the IED

Combustion processes directly associated with the activities covered by these BATC. Provided that the gaseous products of combustion are put into direct contact with material (such as direct feedstock heating or direct feedstock drying). This was agreed by the TWG as appropriate for the scope for the review.

UK legislation: Activities proposed for inclusion

The TWG members discussed the detailed scope of the review as described in the relevant regulations which cover the UK devolved governments.

The TWG agreed by consensus that the review should include surface treatment processes regulated under Section 2.3 Part A, as described in the Environmental Permitting Regulations of England and Wales, Pollution Prevention and Control regulations of Scotland or the Pollution Prevention and regulations of Northern Ireland. This covers surface treating metals and plastic materials using an electrolytic or chemical process where the aggregated volume of the treatment vats exceeds $30m^3$.

A comment was made in the FPIQ responses stating that EPR Part B processes should be excluded. These are processes regulated by local authorities in England and Wales primarily for emissions to air. For the STM sector these include sites where the aggregated vats are less than $30m^3$. This was discussed by the TWG, and it was agreed by consensus to exclude Part B processes.

The TWG discussed the inclusion of other listed Section 4.2 activities involving a surface treatment process. The appropriate processes that might fall under Section 4.2 include electroplating with cadmium, which is the same as a Section 2.3 surface treatment process, except that there is no minimum threshold for the volume of treatment vats. It is noted that in the PPC Regs (Scotland), electroplating with cadmium can fall under Section 2.3 A(b) with no qualifying threshold for the volume of treatment vats. For example, chemical milling using hydrochloric and hydrofluoric acids, and regulated under Section 4.2, might also be included in this review

because the process is similar to surface treatment processes which fall under Section 2.3. With the exception that there is no chemical change to the surface because the surface layers are simply removed by the process. The TWG agreed this by consensus.

A question was asked by a respondent to the FPIQ for STM sites regulated under Section 4.2 to be restricted to 4.2(e) and use of cadmium only. It was agreed by the TWG that any activity included in Section 4.2 Part A1 (b), (c), (d) or (e) or (f) would be included if there is a reason to include it. Such as the process being of a similar type with a similar environmental profile to processes regulated under Section 2.3. After clarification and discussion, the TWG agreed this by consensus. The detailed scope based on UK legislation is in Appendix 2 at the end of this Summary Note.

Additional activities proposed for inclusion

Some semiconductor manufacturing sites are regulated in the UK (specifically England and Wales) under EPR Schedule 1, Section 4.2. There is potential for the industry to grow, therefore it was proposed to include semiconductor manufacturing in the BATC review, as surface treatment processes are used.

The TWG discussed the scheduled activity reference for this and the need to include clarity on the inclusion in the scope. Specifically, this could be covered by the Surface Treatment Using Organic Solvents BATC (via the appropriate reference in the regulations). They agreed that the activity fits best in the STM review scope due to the processes undertaken. The TWG also discussed the relatively small scale of the current industry in the UK, and that better communication with the semiconductor industry would be necessary to support the review.

Following discussion, the TWG agreed by consensus that semiconductors should be included in the scope of the STM BREF review.

The TWG then discussed the water-based pretreatment processes used in vitreous enamelling, and if the similarities to other STM activities would mean this was appropriate for inclusion in the UK BAT review scope. It is currently viewed in the UK as a coating process and is regulated in the UK as a dry application process under Section 6.4 Part B. However, because there is a chemical change in the surface it might be a relevant process as it is similar to other STM processes, rather than simply coating the substrate.

Following TWG discussion it was agreed that not enough was known about vitreous enamelling as a surface treatment process. It was further agreed that it would be included in the evidence collection phase, to gather more information to support a decision about whether to include vitreous enamelling in the STM BATC review.

A comment made in response to the actions from the Kick Off meeting has identified that there are few vitreous enamellers remaining in the UK, and that the Vitreous Enamel Association has closed. A further action is needed for the TWG to decide whether vitreous enamelling should be included in the scope of this review.

Processes included in scope

For the STM UK BAT review, proposals were made to include surface treatment processes based on the activities described in UK legislation. Including those from existing regulatory guidance and standards, including the ‘core activities’ in the 2006 STM BREF.

In addition, activities were proposed to be included which are named as meeting the description in the England and Wales Regulatory Guidance Note No. 2 (RGN2): Understanding the meaning of regulated facility. Specifically in Appendix 1: Interpretation of Schedule 1 to the Regulations for England and Wales.

Some of the additional processes named in RGN2 are included in the 2006 STM BREF as pre-treatments or are the ‘core activity’ described in a wider term. Specific ‘core activities’ in the 2006 STM BREF are viewed by the guidance in RGN2 as not meeting the activity description ‘*Surface treatment of metals or plastic materials using an electrolytic or chemical processes’.* These are electrophoretic lacquering or painting, colour dyeing and chemical milling.

A distinction was made by a member of the TWG to clarify that these are core processes rather than the scope which is based on legislation.

Core Processes from BREF 2006

Comments were made in the responses to the FPIQ that electroplating of metals should include plating on plastics and electroforming as a process. The TWG commented that the question should not specify individual metals and not limit processes in the BATC review. Also, the description should be changed to include all electroplating. Following further discussion, the TWG agreed that plating on plastics would be included, and that the description should include electroplating and electroforming.

There was further discussion around electrorefining, which was confirmed to be a plating process. The TWG members were given an action to provide the process description for electrorefining. In response to the actions the following definition was supplied by the TWG:

> ‘***Electrorefining*** *is a process used to purify metals by using* ***electrolysis****. In this method, an impure metal is made the* ***anode*** *(positive electrode), and a pure metal sheet is used as the* ***cathode*** *(negative electrode). Both electrodes are placed in an* ***electrolyte solution*** *that contains a salt of the metal to be purified’.*

It was highlighted in a response to the FPIQ that there are 2 methods of anodising: dye anodising and electrolytic colouring. The TWG agreed the description of anodising should include both.

A question was asked in a response to the FPIQ if chromium conversion coatings are relevant for post trivalent chromium plating in the form of a lacquer? It was noted

in the kick-off meeting that such processes change the nature of the surface and the TWG agreed by consensus that this should be included in evidence collection.

It was asked in a response to the FPIQ if chemical milling should include electrochemical milling. The TWG agreed this should be included in the list of processes and it was noted chemical milling is equivalent to electrochemical polishing.

Several FPIQ responses highlighted that certain processes need further information. The TWG was asked what information would be needed, and in what form, to enable these processes to be included in scope. The TWG discussed specific examples from the core processes including alkali etching. The TWG commented that the process description of lacquering needs clarification, for example if lacquering is by immersion.

There was TWG discussion about etching of aluminium in response to a question raised in the FPIQ. Comments were made that etching is also appropriate as a process for other metals. The TWG further agreed that surface etching should be included to reflect that it is part of the pre-treatment process for electroplating of plastics.

There was a discussion about oiling. It was confirmed by the TWG that it is still in used for aluminium as a protective film. Oiling is not strictly a surface treatment because it does not alter the substrate of the item being treated. However, it is an intrinsic process that takes place as part of the overall activity, and therefore, oiling will be in scope of the STM review.

Additional processes listed in Regulatory Guidance Note 2 (RGN2)

There was additional discussion about the specific processes described in RGN2.

Comments were made that stripping is a pretreatment, and it was agreed that stripping needs to be defined in more detail. The TWG agreed that stripping of other coatings should not be included as this would not alter the substrate surface.

Pickling was also discussed, and comments were made that it overlaps with the Ferrous Metals Processing Forming (FMPF) BATC, but it is also relevant as a process in the STM sector. A question was asked about the term ‘activation’. A TWG member commented that activation included making a surface ‘sticky’ for further surface treatment.

A response to the FPIQ said that further information was needed about electrolytic cleaning if metal is removed as ions’, but no further comments were made by the TWG relating to this specific process.

Following the discussion described above, the TWG agreed that all the processes listed in the 2006 BREF should be included in the STM BATC review. The TWG agreed to review the current descriptions given in the 2006 BREF to confirm that they are accurate for the processes used in the UK. All the processes listed in RGN2 should also be included.

The full list of processes included in the scope are:

- All electroplating (including but not limited to copper and copper alloy plating; nickel electroplating; chromium plating; zinc and zinc alloy plating; cadmium plating; tin and alloy plating; precious metal plating).
- Autocatalytic plating (catalytic chemically reduced coatings).
- Immersion or displacement coatings (non-catalytic chemically reduced coatings).
- Electropainting or electrocoating.
- Lacquering.
- Oiling.
- Anodising.
- Colour anodising on aluminium.
- Sealing following anodising.
- Phosphating layer conversion coatings.
- Chromium conversion coatings.
- Metal colouring.
- Bright dipping.
- Chemical blacking - oxide coatings.
- Brightening.
- Etching – alkaline etching of aluminium and any other substrate as relevant.
- Chemical milling.
- Passivation.
- Electropolishing.
- Pickling.
- Activation.
- Decorative oxidation.
- Stripping (removal of plated metal).
- Surface etching.
- Electrolytic cleaning if metal is removed as ions.

Further processes for inclusion

The following processes were suggested in the FPIQ as new processes for inclusion in the UK BAT STM review:

Immersion Painting

Immersion painting including using solvent-based paints, water-based paints, specialised immersion coatings and powder coatings.

There was a brief discussion about the potential for some types of immersion coating processes to be included in the STM BAT review, whereas other types might be covered by other BAT conclusions.

Self-Assembled Monolayers (SAMs) and Sol-gel coating

The TWG agreed that more information was needed about SAMs and Sol-gel coatings to decide whether they should be included in the STM BAT review. The TWG agreed to an action to provide further information.

Deep spin coating

There was discussion about whether deep spin coating was the same as dip spin coating and it was confirmed by a TWG member that there is a hot dip spin coating currently in use. The TWG agreed to an action to provide more information about the process of dip spin coating, to support its inclusion in the BATC review.

Waxing

Following discussion, it was agreed that waxing may be included if it is an intrinsic process but also that more information is needed. The TWG agreed to an action to gather more information about this process.

The TWG agreed to an action, to gather more information about these processes by speaking to experts in the field, to decide whether to include or exclude from evidence collection.

Intrinsically linked processes

In addition to the main process steps described above, permitted installations may require other processes to be undertaken. These processes, which potentially cause emissions and pollution, are intrinsically linked if they must be undertaken at the same installation, and when they have a direct technical connection with the main process steps. Examples may include post treatment processes which must be undertaken before the workpiece leaves to installation to prevent quality degradation and cannot therefore be undertaken at another site.

It is proposed that all processes intrinsically linked to the surface treatment activity (as defined by the activity description in the IED), which may affect consumptions or emissions, should be included in the scope. Processes may be in scope whether or not they are listed activities in their own right. If a process could be undertaken at another site and is not intrinsically linked the process should be excluded from the STM review.

The TWG considered the following intrinsically linked processes:

- Handling techniques for loading and processing (including those for jigs, barrels, continuous coil, aluminium lithography plates [sheet processing], printed circuit board manufacturing and semiconductor manufacturing).
- Pre-treatment of workpiece or substrate.
- Rinsing and the management of drag-in/drag-out.
- Post-treatment activities (drying, and heat treatment for hydrogen de-embrittlement).
- Water and wastewater treatment, process solution maintenance and in-process materials recovery.

There was discussion by the TWG about the difference between delivery and storage of workpieces. It was agreed that the wording needs to include ‘within the installation’ to clarify the boundary where the responsibility for goods and chemicals is under the operators control to minimise potential impact on the environment. The TWG agreed this point by consensus.

Following discussion, the TWG agreed that the intrinsically linked processes above should be included in the review.

Coating activities

A comment in the FPIQ requested the inclusion of Section 6.4 Part(B)(a)(i) 20 or more tonnes of printing ink, paint or other coating material, which is applied in solid form, and (ii) 20 or more tonnes of any metal coating which is sprayed on in molten form. The reasoning given was that they may be captured by the inclusion of Part A(2) 2.3 (a)(iii) activities (*Surface treating metals and plastic materials using an electrolytic or chemical process where the aggregated volume of the treatment vats is more than 30m^3 and where the activity is carried on at the same installation as one or more activities falling within— (iii) Part A(2) or Part B of Section 6.4.)* which covers non-solvent activities such as powder coating as these are not caught by other BREFs or UK BATC.

In contrast multiple FPIQ responses said coating activities (powder coating, molten metal spray coating, vitreous enamelling, chemical vapour deposition, physical vapour deposition) should be excluded as they don't meet the definition of surface treatment in the original BREF and that this could impact climate change agreements and ‘min/met exemptions based on IPPC / EPR’.

The TWG was asked to consider which of the coating activities (powder coating, molten metal spray coating, vitreous enamelling, chemical vapour deposition, physical vapour deposition) should be included in the STM BAT review.

Following discussion, it was agreed that powder coating for aluminium processes is intrinsically linked and therefore may be included in the BATC. Otherwise, powder coating is a Part B regulated activity where over 20t/year and therefore will be excluded from the STM BATC review.

The TWG discussed molten metal spray coating, chemical vapour deposition, physical vapour deposition and agreed that more information should be gathered to understand environmental impacts of these processes. The TWG agreed an action to invite experts in these fields to join the TWG.

Activities proposed for exclusions within the final draft scope

Some comments were made in responses to the FPIQ relating to proposed exclusions from the STM scope. These were to exclude surface treatment activities covered by the Draft UK BATC for Ferrous Metals Processing – Forming (FMPF), the Draft UK BATC for Ferrous Metals Processing – Galvanising (FMPG), the UK BATC for Foundries (FDRY) (currently being reviewed), and those covered by the Surface Treatment with Solvents BREF. The TWG discussed these comments and agreed by consensus that these activities will be excluded.

One additional activity was proposed in the FPIQ to suggest that continuous wire strip and sheet plating should be included, considering the interface with Ferrous Metals Processing Forming (FMPF). The Section 2.3 surface treatment used in cold rolling and wire drawing is covered by the Draft FMPF BATC. Even if there is no hot rolling or hot dip coating carried out (or is carried out but below the qualifying

thresholds). This means the Draft FMPF BATC covers installations which may be regulated under the Section 2.3 activity used in cold rolling or wire drawing. The TWG agreed that the Draft UK BATC for FMPF covers this activity.

One response to the FPIQ said that medium combustion plant should be included in the BATC. The TWG discussed this point and agreed by consensus to exclude onsite combustion when it is already covered by the LCP BREF or the MCP directive.

Overlap with other legislation

The potential for some emissions to be covered by other legislation was discussed, specifically relating to Control of Substances Hazardous to Health (COSHH) and UK Registration, Evaluation, Authorisation and Restriction of Chemicals (UK REACH).

Responses to the FPIQ mentioned that some pollutants are covered by other regulations – e.g. UK REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), which is an important regulation used to protect human health and the environment against the harmful effects of chemical substances. However, the requirement to comply with other regulations does not prevent the development and applicability of UK BATC as UK BAT applies to process emissions. This was discussed and agreed by the TWG.

Key environmental issues included in the BATC review

Emissions to water

The following table summarises the decisions made by the TWG following discussion to collect emission data for emissions of these pollutants to water. Many of the KEIs included were agreed without substantive discussion.

Pollutant	Additional notes	TWG agreed position
Copper and compounds (as Cu)		To include as KEI and consider AEL/AEPL
Nickel and nickel compounds (as Ni)		To include as KEI and consider AEL/AEPL
Chromium and compounds (as Cr)		To include as KEI and consider AEL/AEPL
Zinc and compounds (as Zn)		To include as KEI and consider AEL/AEPL
Cadmium and compounds (as Cd)		To include as KEI and consider AEL/AEPL
Hexavalent Chromium		To include as KEI and consider AEL/AEPL
Silver		To include as KEI and consider AEL/AEPL
Arsenic and compounds (as As)		To include as KEI and consider AEL/AEPL

Pollutant	Additional notes	TWG agreed position
Lead and compounds (as Pb)		To include as KEI and consider AEL/AEPL
Sulphides (includes organosulphides)		To include as KEI and consider AEL/AEPL
Fluorides (as Total F)		To include as KEI and consider AEL/AEPL
Total Organic Carbon or COD		To include as KEI and consider AEL/AEPL
Halogenated Organic Compounds (as AOX)		To include as KEI and consider AEL/AEPL
Phenols (as Total C)		To include as KEI and consider AEL/AEPL
Phosphates		To include as KEI and consider AEL/AEPL
TSS		To include as KEI and consider AEL/AEPL
EDTA		To include as KEI and consider AEL/AEPL
Cyanides and free CN		To include as KEI and consider AEL/AEPL
Total Nitrogen		To include as KEI and consider AEL/AEPL
Trichloromethane		To include as KEI and consider AEL/AEPL
Poorly degradable complexing agents other than EDTA		To include as KEI and consider AEL/AEPL
Acute Toxicity		To include as KEI and consider AEL/AEPL
Aluminium	The TWG noted that aluminium emissions are from processes other than anodising	To include as KEI, assess for significance and consider AEL/AEPL
Boron		To include as KEI, assess for significance and consider AEL/AEPL
Cobalt		To include as KEI, assess for significance and consider AEL/AEPL
Iron		To include as KEI, assess for significance and consider AEL/AEPL
Selenium		To include as KEI, assess for significance and consider AEL/AEPL
Tin		To include as KEI, assess for significance and consider AEL/AEPL
Chlorides (as Total Cl)		To include as KEI, assess for significance and consider AEL/AEPL

Pollutant	Additional notes	TWG agreed position
Mercury	Mercury data is often collected via mass balance	To collect evidence of significance to decide if to include as KEI
Organotin		To collect evidence of significance to decide if to include as KEI
Surfactants - other than nonylphenol ethoxylates (NPEO) / octylphenol ethoxylates (OPEO)	Surfactants were specifically raised as an issue, and it was agreed that further information will be supplied by the TWG.	To include as KEI, assess for significance and consider AEL/AEPL
Octylphenols and Octylphenol ethoxylates		To include as KEI, assess for significance and consider AEL/AEPL
Nonylphenols and Nonylphenol ethoxylates		To collect further information to decide if appropriate to include as KEI
Trichloroethylene		To collect further information to decide if appropriate to include as KEI
Phosphorus as Total P	The TWG identified a nickel based (nickel phosphorous alloy) process that should also be included.	To collect further information to decide if appropriate to include as KEI
pH		To collect evidence for further assessment or contextual information
Conductivity		To collect evidence for further assessment or contextual information
Sulphates	Identified by the TWG to be included and comment made that this is relevant when the etch is ‘standing still’.	To collect further information to decide if appropriate to include as KEI
Formaldehyde	Identified by the TWG to be included (noted that there is 1 permitted discharge)	To collect further information to decide if appropriate to include as KEI

The TWG were asked to provide process flow diagrams to help identify specific process types and emissions, which will support evidence collection.

The TWG discussed data availability and asked what data already exists. The quantity of available data for evidence collection was also raised by the TWG. The potential of pollutant impact was identified as the critical component that needs to be identified at this stage. Further discussion highlighted that the definitions used in evidence gathering will be critical. For example, iron and aluminium are used in effluent treatment as well as in surface treatment processes so the source of pollutant needs to be clear.

Where emissions were felt to be insignificant or below reporting thresholds the proposal was to include as KEIs to assess significance and then to decide whether to define an AEL/AEPL.

Additionally, mercury and organotin were proposed as potentially not to be included as KEIs. Following discussion, the TWG agreed that evidence should be collected for these pollutants, to make sure the correct decision can be made about whether to include or not in the BAT conclusions. Issues around data accuracy were also flagged, and a comment made that mercury measurements are collected via mass balance methods. The TWG further discussed pH and conductivity. It was commented that all sites continuously monitor pH as it is required for the water discharge consent.

The UK BAT Team have been directed by the Industrial Pollution Control (IPC) Standards Council to consider low volume high impact chemicals such as PFAS as part of all UK BAT reviews. The following table summarises the discussion by the TWG.

KEI	**Additional notes**	**TWG agreed position**
PFAS (includes PFOS) and other low volume high impact chemicals	Other processes were identified that may emit PFAS/PFOS. The TWG were asked to identify any other low volume high impact chemicals appropriate for the BATC review.	To collect data to determine if it would be appropriate as a KEI and consider AEL/AEPL

Emissions to air

The STM industry is not considered to be a major source of air pollution, but it can be a source of hazardous emissions to air of particulates, VOCs, acid/alkaline gases, metals, and of combustion by-products such as CO, CO_2 and NO_X.

Most responses to the Citizen Space survey agreed that gases either with or without a greenhouse effect should be included.

The responses to the initial engagement collected through the FPIQ about emissions to air were discussed by the TWG. Many comments in the FPIQ were made about whether specific emissions to air would be significant. It was proposed that these emissions are included in evidence collection to enable a final assessment of their impacts.

The TWG discussed and agreed by consensus to include the parameters in the following table as KEIs, to collect data to assess significance, and then consider setting an AEL/AEPL.

Pollutant	Additional notes	TWG agreed position
Total volatile organic compounds (TVOCs)	The TWG recommended that including any CMR data is considered important in addition to the TVOC data.	Include as KEI and consider an AEL/AEPL
Nitrogen Oxides (NO_X)		Include as KEI and consider an AEL/AEPL

Hydrogen Cyanide (HCN)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Dichloromethane (DCM)	The TWG highlighted DCM as having a new Environmental Assessment level (EAL) due to its environmental impacts	Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Zinc and compounds (as Zn)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Nickel and compounds (as Ni)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Tetrachloroethylene (PER)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Chromium and compounds (as Cr)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Hexavalent chromium		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Ammonia		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Sulphuric acid		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Formaldehyde		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
PFAS (includes PFOS)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Copper and compounds (as Cu)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Cadmium and compounds (as Cd)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Lead and compounds (as Pb)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Hydrogen chloride (HCL) (gaseous chlorides expressed as HCl)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Hydrochloric acid		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Hydrogen fluoride (HF) (gaseous fluorides expressed as HF)		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Dust		Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Mercury		Include as KEI, collect data to assess significance, then consider an AEL/AEPL

Cobalt	Identified by the TWG as an additional pollutant to be included	Include as KEI, collect data to assess significance, then consider an AEL/AEPL
Carbon Monoxide		Include as KEI and collect data to assess significance
Nitrous Oxide		Include as KEI and collect data to assess significance
Arsenic		Include as KEI and collect data to assess significance
Benzo(b)fluoranthene		Include as KEI and collect data to assess significance
Benzo(a)pyrene		Include as KEI and collect data to assess significance
Benzo(k)fluoranthene		Include as KEI and collect data to assess significance
Indeno(1,2,3-cd)pyrene		Include as KEI and collect data to assess significance
Tetrachloroethane (1,1,2,2-Tetrachloroethane)	The TWG identified that tetrachloroethane is no longer used in STM activities	Include as KEI and collect data to assess significance
Trichloroethylene	The TWG identified that trichloroethylene is only used in closed systems	Include as KEI and collect data to assess significance
Greenhouse gases (GHGs)		Include as KEI and collect evidence for further assessment or contextual information
Carbon Dioxide (CO_2)		Include as KEI and collect evidence for further assessment or contextual information
Hydro-fluorocarbons (HFCs)		Include as KEI and collect evidence for further assessment or contextual information
Hydrochlorofluorocarbons (HCFCs)		Include as KEI and collect evidence for further assessment or contextual information
Non-methane volatile organic compounds (NMVOCs)		Include as KEI and collect evidence for further assessment or contextual information

The TWG considered data collection more widely. The significance of specific emissions was discussed but the UK BAT process will not put a restriction in terms of limits for data collection. It was commented that evidence collection should capture speciation of compounds and enable ones to be identified that have been missed off this list.

The TWG discussed GHGs, CO_2, HFCs, HCFCs and NMVOCs and questions were asked about how they are to be monitored or calculated, whether there is existing information on source and scale, and the challenges of stack location. It was highlighted that there is a need to understand where CO_2 originates from in the STM process.

It was clarified that there are no plans for a CO_2 AEL, but data needs to be gathered to assess significance and contextual information as part of evidence collection. A comment was made that data collection must take ambient temperature into account.

A comment was made in response to the Summary Note to include HNO3 and SOx/SO2 as we do not know what the actual emissions will be, and to gather data on the proportion of emissions: HNO3/NOx and H2SO4/SOx/SO2. This will be clarified with the TWG.

Resource efficiency, climate change, circular economy and amenity issues

The TWG discussed resource efficiency, climate change, circular economy and amenity issues and agreed by consensus to include those listed below as KEIs.

KEI	Additional notes	TWG agreed position
Energy Efficiency		Include as KEI Collect data to assess significance then consider AEL/AEPL
Techniques and Best practice to reduce energy consumption		Include as KEI Collect data to assess significance then consider AEL/AEPL
Specific Energy Consumption		Collect data for contextual information
Contextual information (i.e. plant configuration, system, boundaries, operational regime, type of furnaces, type of processes and fuels, level of aggregation of consumption data, raw materials, product type, energy management systems, energy recovery/reuse flows)		Collect data for contextual information
Water Efficiency		To include as KEI
Amount of water consumed and amount of waste water discharged		Include as KEI Collect data to assess significance then consider AEL/AEPL
Contextual information (i.e. water reuse, type of processes, level of aggregation of consumption data, raw materials, product types)	It was agreed that this will be covered in the evidence collection process to ensure fair comparisons are made in developing BATC.	Collect data to assess significance then consider AEL/AEPL
Consumption of important raw materials	Anonymised data collection needed	To include as KEI
Replacement of virgin raw materials	Definition of virgin needed	To include as KEI
Circular Economy	The TWG highlighted the example of end-of-life vehicles	Collect evidence and contextual information to better

KEI	Additional notes	TWG agreed position
	applies to some of the installations operations. The TWG agreed by consensus to include this in the BATC review.	understand the potential application of circular economy for the sector
Management of waste	The TWG agreed by consensus to include this.	Include as KEI Collect evidence to assess significance then consider AEL/AEPL
Decarbonisation		To include as KEI
Climate Change Adaptation		To include as KEI
Noise	Noise will be installation and situation/receptor specific	To include for evidence collection to assess significance and consider AEL/AEPL
Odour	Odour is installation specific and usually related to chemicals used	To include for evidence collection to assess significance and consider AEL/AEPL

Comments were received in the CS survey around the importance of waste and waste disposal, and that reducing waste will have the benefit of reducing the associated pollution.

The TWG discussion referred to the diversity of the sector and the need to specify this in energy efficiency measures. How the data is collected is also important, and care is needed to ensure data is comparable and consistent. Most of the data is already collected for other purposes such as for climate change agreement requirements and emissions trading agreements. Comments were made about the importance of energy consumption and efficiency for the STM sector.

There was discussion about whether the workpiece would be classed as a raw material and agreement that raw materials would include chemicals. Also, discussion about the Chemical Management System (CMS) and differing requirements that brings, such as for storage.

The TWG identified that the definition of virgin raw material may need clarity. It was agreed that anonymised evidence submission for some of these parameters may be important.

Comments were made that customer needs may reduce or prevent the ability to substitute chemicals or techniques. Design specifications may not rest with STM operators, which will restrict options to replace raw materials. The Chair clarified that is it the responsibility of the installation to protect the environment and that this needs to be balanced against the customer’s requirements.

The TWG identified replacement of virgin raw materials could be focussed on the surface treatment materials rather than the work piece. Purchasing power for

materials such as recycled zinc was mentioned. Examples such as anode impurities, and water use and reuse were discussed.

It was highlighted that evidence collection flow diagrams will help clarify what is needed to identify possible options for replacing raw materials.

The TWG discussed the importance of climate change and the need for industry to adapt. Decarbonisation was described as a longer-term process for the sector. Such as moving to a green electricity supply or using hydrogen to produce electricity. The TWG identified that climate change adaptation is more urgent and is required as part of permitting, so therefore should be included.

The TWG also highlighted the potential for some of these issues to be cross sector. Sector specific evidence is key to support developing BATC. It was commented that it is unlikely for there to be an AEL/AEPL based on other sector reviews.

The TWG discussed the potential emission of odours from strong smelling chemicals that can be an issue to local residents. The diversity of the sector means that it could be an issue for some processes and be site specific. Members of the public might not report via the regulator and possibly could approach site directly with complaints. It was agreed that the BAT review would collect more information on odour from the STM industry to assess this.

There was a brief discussion about scavengers as a question was included in the FPIQ, however it is not thought to be an issue for this sector and not relevant to the BAT review.

The TWG identified that noise will be installation and situation/receptor specific, and it was agreed by consensus to assess for significance as a KEI.

Techniques

After discussion at the kick-off meeting the TWG agreed that most techniques presented in the kick off paper should be included as still relevant. Some of the techniques that were thought to be emerging, were confirmed by the TWG that they are now in use. Some techniques received responses in the FPIQ of being obsolete, however the TWG confirmed that most of these are currently relevant and still in use.

A summary list of all relevant techniques under the following headings are listed in Appendix 3:

1. Management techniques.
2. Installation design, construction and operation
3. General operational issues
4. Utility inputs and their management
5. Process operations
6. Other techniques to optimise raw material usage
7. Substitution - choice of raw materials and processes
8. Common techniques for treating waters and aqueous solutions: feed-water, rinses, waste water treatment, process solutions and materials recovery
9. Process solution maintenance

10. Recovery of process metals
11. Post-treatment activities - techniques relevant to the determination of BAT
12. Continuous coil - large scale steel coil
13. Printed circuit board processing
14. Disposal of solutions
15. Waste water emission abatement techniques
16. Waste management techniques
17. Air emission abatement techniques

It was highlighted that noise techniques were missing from the list and noted by the Chair that these should be added.

Techniques that need further information

Based on responses to the FPIQ some techniques were presented in the kick-off information paper as needing further information. No comments were made on specific techniques during the meeting, and it was agreed that the TWG would assist with defining those techniques identified as requiring updating or improving after the meeting. So that data can be collected on these techniques during the evidence collection stage of the STM review. Techniques needing further information are listed below:

1 Management techniques
1.4 Benchmarking performance and environmental parameters
3 General operational issues
3.4 Agitation of process solutions
3.5 Maintenance of plant and equipment
4 Utility inputs and their management
4.5 Optimising process electrical efficiency
5 Process operations
5.6 Zero discharges to water
7 Substitution - choice of raw materials and processes
7.6 Substitution for, and minimisation of, hexavalent chromium
7.7 Minimisation of release of hexavalent chromium from treated surfaces
7.8 Chromium electroplating techniques
7.8.1 Hexavalent chromium plating
7.8.2 'cold chromium' hexavalent process
7.8.3 Trivalent chromium chloride-based electroplating process
7.8.4 Trivalent chromium sulphate electroplating process
7.9 Chromium free processes - other coating processes
7.10 Chromium conversion coatings
7.10.1 Hexavalent chromium
7.10.2 Trivalent chromium conversion process
7.10.3 Chromium-free conversion process
7.11 Chromic acid anodising
7.12 Phosphochromating (phosphating with chromium)
7.14 Substitution and choices for degreasing
7.14.2 Solvent degreasing
7.14.5 Biological degreasing

7.14.6 Dry ice
7.15 Other degreasing techniques
7.16 Substitution by alternative process
10 Recovery of process metals
10.3 Chromating
15 Waste water emission abatement techniques
15.12 Zero discharge techniques

One response to the FPIQ suggested that chromic acid anodising should include tartaric acid anodising and phosphoric acid anodising. The TWG also agreed to provide further information to inform the evidence collection phase.

Proposed additional techniques

The following were proposed in the FPIQ as techniques:

1. Physical measures for energy efficiency and control of air emissions e.g. croffles.
2. Fire prevention (incl. electrical) and firewater management. Comments were made about sprinklers (should be targeted), there should be a change to fire risk management and that there are risks from firefighting foam (PFAS).
3. Containment of process chemicals, solutions and management for accidents.
4. Effluent treatment plant operator competence and ensuring correct analytical methods are used for samples taken. Comments were made by the TWG that this might be too specific.

TWG discussion highlighted the importance of appropriate fire management techniques and design to prevent environmental impacts. Effluent treatment plant operator competence was highlighted as being included in the wider management systems. A further comment noted that the first, third and fourth points are included elsewhere. Following discussion, the TWG agreed the inclusion of the additional techniques.

Emerging and future emerging techniques

The following techniques were discussed in the Kick-off meeting and are considered to be emerging:

- Ceramic molecular treatment which is a commercially available hybrid technology and an emerging technique.
- Trialled crustacean / crab shell to purify metal finishing effluents - this was described as a process involving sustainable reuse of crustacean shells which absorb copper. The Surface Engineering Association (SEA) have provided information on this.
- LIFE-2-ACID project: New technology to selectively recover zinc and iron chloride from spent pickling aids (SPA) (LIFE16 ENV/ES/000242) – comments were made that this specifically relates to galvanising.
- FP7: AMAZE (Additive Manufacturing Aiming Towards Zero Waste and Efficient Production of High-Tech Metal Products).

The following emerging techniques suggested in the kick off paper received no comments in the FPIQ and did not receive any specific comments in the kick-off meeting. They may be still considered to be emerging and will be included in evidence collection:

- Eco-innovation.
- FP7: HIMMOVAL (High speed metallic material removal under acceptable surface integrity for rotating frame).
- FP7: EASYFORM (Laser-assisted metal spinning for an efficient and flexible processing of nickel- and titanium-alloys).
- LIFE DIME project: Demonstration of an innovative technology for the minimisation of the environmental impact of metal finishing processes (LIFE16 ENV/ES/000410).
- FP7: Tartaric Sulphuric Acid Anodizing (TSAA): VALIDATETSAA (Validate of TSAA coating technology. Development of procedures and standards manual. Technical and economic study
- Purifying the hard chromating surface treatment baths from pollutants using ion exchangers and evaporators.
- Recycling of pressed aluminium hydroxide sludge.
- Combining Six Sigma and Lean methodologies with wastewater batch treatment processes.
- Wastewater treatment with electrolysis.
    - Single-stage separation of metals from wastewater.
    - Recycling aluminium hydroxide sludge for use in mineral wool insulation.
    - LIFE EMPEREUR project: Use of emulsion pertraction to extend the lifetime of the passivating baths (LIFE03 ENV/NL/000476).

No specific comments were made about the following group of PCB techniques, but a general comment was made that more PCB expertise was needed in the TWG, and an action was agreed by the TWG to recruit PCB industry representatives.

- PCBs: Laser direct imaging.
- PCBs: High density interconnects (HDI).
- PCBs: Embedded passives.

Approaches that may be considered best practice

These are approaches that may be considered best practice forming part of a broader technique and could be considered for inclusion in evidence collection. Following discussion by the TWG, it was agreed that the following list represents approaches that are best practice:

- Automation of chemical dosage.
- Circulating cooling water in a closed loop system.
- Optimising the ventilation for increased energy efficiency.
- Closed-loop wastewater treatment plant with vacuum evaporator. It was commented that this is an established technique for cadmium.

Further discussion concluded that more information is needed on the following and will be included in the evidence collection phase:

- Digitalisation and mapping of resource use. It was agreed by the TWG that this may be an emerging technique.

- Using excess heat for the local district heating. The use of excess heat was discussed and that sites should be heat network ready for district heating. Heat integration should be included where appropriate.
- Automation and digitalisation of new and existing STM equipment for hanging and pickling of goods. Following discussion, it was agreed that the TWG would provide further information where available.
- Simulation of electrocoating for optimisation. It was noted that this is already in use as a training tool.

Potentially obsolete techniques

The TWG confirmed that the following techniques are obsolete and now not in use in the UK:

- 'Cold chromium' hexavalent process.
- On-site recovery of chromium from sludge of waste water treatment.
- On-site recovery of chromium from waste water.

Substitution by trivalent chromium plating for hexavalent chromium in hard chromium applications using modified pulse current was also discussed. It was noted that this has been removed from the EU D1 BREF review. However, there are some examples where this is in operation for very specific applications, and a TWG member will provide further information about this technique. Also, a comment was made that the ‘modified pulse current’ is not used for this technique. It was agreed that it is not relevant for the UK STM BAT conclusion review.

Further comments were made by the TWG that the preference is to prevent chromium from entering the waste water.

It was mentioned that electrolytic chromium plating - closed loop electroplating might be replaced and may become obsolete in the future.

The following techniques were discussed and confirmed as being not suitable for inclusion in the STM review:

- Recycling of degreasing bath water for pH adjustments in rinsing baths.
- Holistic approach in the determination of sustainable techniques. It is BAT to assess the individual situation of the respective surface treatment line in depth when deciding about the installation of a particular technique.

Appendix 1: Key terms and definitions

Within a UK context, key terms have been defined in the following way to ensure clarity with the UK BAT process:

BAT Conclusions	A document containing the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures.
Available techniques	Techniques developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the United Kingdom, as long as they are reasonably accessible.
Best	The most effective in achieving a high general level of protection of the environment as a whole.
Best available techniques (BAT)	The most effective and advanced stage in the development of activities and their methods of operation, which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions, designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole.
Emission levels associated with the best available techniques (BAT-AEL)	The range of emission levels obtained under normal operating conditions using a best available technique or a combination of best available techniques, as described in BAT Conclusions, expressed as an average over a given period of time, under specified reference conditions.
Emission limit value (ELV)	The mass, expressed in terms of certain specific parameters, concentration and/or level of an emission, which may not be exceeded during one or more periods of time.

Techniques	These include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.
BAT Associated Environmental Performance Level (BAT-AEPL)	The BAT Associated Environmental Performance Level which may include an emission level, consumption level or other indicator of performance such as abatement efficiency.
Intrinsically linked process	A process is intrinsically linked if it must be undertaken at the same installation where a permitted activity takes place and has a direct technical connection with the main process steps.

Appendix 2: Scope of BAT review

Scope of Review

Principal activities for inclusion within the initial scope

These activities, which are regulated by the Industrial Emissions Directive (IED), are incorporated into UK law. They are described in Section 2.6 and 6.11 of Annex I to the IED.

The following activities described in the Industrial emissions directive Annex I to Directive 2010/75/EU are included:

2.6 Surface treatment of metals or plastic materials using an electrolytic or chemical process where the volume of the treatment vats exceeds 30m^3.

6.11 Independently operated treatment of wastewater not covered by Directive 91/271/EEC (*provided that the main pollutant load originates from the activities covered by these BAT conclusions*).

Associated activities included in scope, but which are not specified activities in the IED include:

- The combined treatment of waste water from different origins, provided that the waste water treatment is not covered by Directive 91/271/EEC and that the main pollutant load originates from the activities covered by these BAT Conclusions.

- Combustion processes directly associated with the activities covered by these BAT Conclusions that: generate hot gases for direct contact heating, drying or any other treatment of objects or materials; or whose radiant and/or conductive heat is transferred to objects or feed material through a solid wall without using an intermediary heat transfer fluid.

Scope of the UK BAT review

The IED was transposed into UK domestic law as follows:

- Environmental Permitting (England and Wales) Regulations 2016.
- Pollution and Prevention Control (Scotland) Regulations 2012.
- Pollution and Prevention Control (Northern Ireland) Regulations 2013.

Activities proposed for inclusion in the UK BAT review scope

The STM UK BATC will mainly (but not exclusively) cover installations where surface treatment is the main activity. All installations where surface treatment occurs are to

be interpreted as installations which carry out any activity falling under Section 2.3 Part A of the relevant UK permitting regulations.

Also agreed to be included in scope are activities falling under Section 4.2 Part A or A(1)(b), (c), (d), (e) or (f), provided they involve a surface treatment, however the activity might not meet the definition of the surface treatment described in Section 2.3 (for example capacity) or as interpreted by the current guidance. However, these activities should be similar in the type of process and environmental profile to be ruled into scope.

Specifically, it is proposed that the following activities listed under S4.2 are within scope of the UK BAT review:

- Electroplating with cadmium, because the process is the same as those falling under S2.3 except that there is no qualifying threshold for the volume of treatment vats. It is noted that in the PPC Regs (Scotland), electroplating with cadmium can fall under S2.3 A(b) with no qualifying threshold for the volume of treatment vats.

- Chemical milling using e.g. hydrochloric and hydrofluoric acids, because the process is similar to surface treatment processes which fall under S2.3, except that there is no chemical change to the surface because the surface layers are simply removed by the process.

It is noted that there are some differences in the written descriptions of the activities between the UK permitting regulations, but the differences do not affect the general principle.

The legislation covering the surface treatment of metals and plastics is derived from the IED and implemented through UK regulation as follows:

In England and Wales under the Environmental Permitting Regulations 2016 Schedule 1 Part 2:

Chapter 2, Production and processing of metals. Section 2.3 *Surface treating metals and plastic materials*

Part A(1)(a) Unless falling within Part A(2) of this Section, surface treating metals and plastic materials using an electrolytic or chemical process where the aggregated volume of the treatment vats is more than $30m^3$.

Part A(2)(a) Surface treating metals and plastic materials using an electrolytic or chemical process where the aggregated volume of the treatment vats is more than $30m^3$ and where the activity is carried on at the same installation as one or more activities falling within:

(i) Part A(2) or Part B of Section 2.1,
(ii) Part A(2) or Part B of Section 2.2, or
(iii) Part A(2) or Part B of Section 6.4.

Chapter 4, The Chemical Industry. Section 4.2 *Inorganic chemicals (provided the activity involves a surface treatment which has been ruled into the scope*)

Part A(1)(b) Unless falling within any other Section, any manufacturing activity which is likely to result in the release into the air of any hydrogen halide (other than the manufacture of glass or the coating, plating or surface treatment of metal) or which is likely to result in the release into the air or water of any halogen or any of the compounds mentioned in paragraph (a)((vi) -*halogens or interhalogen compounds comprising two or more of halogens, or any compound comprising one or more of those halogens and oxygen*)(other than the treatment of water)

Part A(1)(c) Unless falling within any other Section, any manufacturing activity (other than the application of a glaze or vitreous enamel) involving the use of, or the use or recovery of, any compound of any of the following elements— (i) antimony, (ii) arsenic, (iii) beryllium, (iv) gallium, (v) indium, (vi) lead, (vii) palladium, (viii) platinum, (ix) selenium, (x) tellurium, (xi) thallium, where the activity may result in the release into the air of any of those elements or compounds or the release into water of any substance listed in paragraph 7(1) of Part 1 of this Schedule.

Part A(1)(d) Recovering any compound of cadmium or mercury.

Part A(1)(e) Unless falling within any other Section, any manufacturing activity involving the use of mercury or cadmium or any compound of either element or which may result in the release into the air of either of those elements or their compounds.

Part A(1)(f) Unless falling within any other Section, any activity (other than the combustion or incineration of carbonaceous material as defined in the Interpretation of Part A(1) of Section 1.2) which is likely to result in the release into the air of any acid-forming oxide of nitrogen.

Chapter 5, Waste Management. Section 5.7. Treatment of waste water

Part A(1)(a) Independently operated treatment of waste water not covered by the Urban Waste Water Treatment (England and Wales) Regulations 1994 and discharged by an installation carrying out any other Part A(1) or A(2) activity *(provided that the main pollutant load originates from the activities covered by these BAT conclusions*).

In Scotland under the Pollution Prevention and Control (Scotland) Regulations 2012 Schedule 1, Part 1:

Chapter 2, Production and Processing of Metals. Section 2.3: *Surface treating metals and plastic materials*

Part A(a) Surface treating metals and plastic materials using an electrolytic or chemical process where the aggregated volume of the treatment vats exceeds 30m^3,

Part A(b) Surface treating materials using cadmium or any compound thereof where the activity may result in the release into the air or water of cadmium and its compounds, as listed in column 1 of the Table in paragraph 10 of Part 2 of this Schedule, in a quantity which, in any 12 month period, exceeds the background quantity for cadmium and its compounds by more than the amount specified in relation to it in column 2 of that Table.

Chapter 4, The Chemical Industry. Section 4.2 *Inorganic chemicals* (*provided the activity involves a surface treatment which has been ruled into the scope).*

Part A(b) Unless falling within a description in any other Section of any Chapter of this Schedule, any production activity which is likely to result in the release (i) into the air of any hydrogen halides (other than the coating, plating or surface treatment of metal), or (ii) into the air or water of any halogens or any of the compounds mentioned in paragraph (a) (vi) *(halogens or any compound comprising only (aa) two or more halogens, or (bb) any one or more of those halogens and oxygen)* (other than the treatment of water by chlorine) .

Part A(c) Unless falling within a description in any other Section of any Chapter of this Schedule, any production activity which uses, or is likely to result in the release of, hydrogen cyanide or hydrogen sulphide.

Part A(d) Unless falling within a description in any other Section of any Chapter of this Schedule, producing any compounds, or using or recovering any mixture (other than in the application of a glaze or vitreous enamel), containing any of the following substances or their compounds: (i) antimony, (ii) arsenic, (iii) beryllium, (iv) gallium, (v) indium, (vi) lead, (vii) palladium, (viii) platinum, (ix) selenium, (x) tellurium, (xi) thallium, (xii) cadmium, or (xiii) mercury, where the activity may result in the release into the air of any of those elements or their compounds or the release into water of any substance listed in column 1 of the Table referred to in paragraph 10 of Part 2 of this Schedule in a quantity which, in any 12 month period, exceeds the background quantity by more than the amount specified in relation to that substance in column 2 of that Table.

Part A(e) Unless falling within a description in any other Section of any Chapter of this Schedule, recovering any compound of or engaging in any process of production which involves the use of cadmium or mercury or of any compound of either of those elements or which may result in the release to air of either of those elements or their compounds.

Part A(f) Any other activity (except the combustion or incineration of carbonaceous material as defined in Section 1.2) which does not fall within a description in Sections 2.1, 2.2 or 2.3 and which may result in the release into the air of any acid forming oxide of nitrogen.

Chapter 5, Waste Management. Section 5.7: *Treatment of waste water*

Part A Independently operated treatment of waste water not covered by the Urban Waste Water Treatment (Scotland) Regulations 1994 and discharged by an installation carrying out any other Part A activity. (*provided that the main pollutant load originates from the activities covered by these BAT conclusions*).

In Northern Ireland under the Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013 Schedule 1, Part 1:

Chapter 2, Production and processing of metals. Section 2.3 *Surface treating metals and plastic materials*

Part A(a) Surface treating metals and plastic materials using an electrolytic or chemical process where the aggregated volume of the treatment vats is more than 30m^3.

Chapter 4, The chemical industry. Section 4.2 *inorganic chemicals (provided the activity involves a surface treatment which has been ruled into the scope).*

Part A(b) Unless falling within another section of this Schedule, any manufacturing activity (other than the manufacture of chemicals or glass or the coating, plating or surface treatment of metal) which involves the use and may result in the release into the air of any hydrogen halide or any manufacturing activity which uses, or which is likely to result in the release into the air or water of any of the compounds mentioned in paragraph (a)(vi)(*halogens or interhalogen compound comprising two or more of halogens, or any compound comprising one or more of those halogens and oxygen*), other than the treatment of water by chlorine.

Part A(c) Unless falling within another section of this Schedule, any manufacturing activity, other than the application of a glaze or vitreous enamel, involving the use of any of the following elements or compound of those elements or the recovery of any compound of the following elements: antimony, arsenic, beryllium, gallium, indium lead, palladium, platinum, selenium, tellurium, thallium, where the activity may result in the release into the air of any of those elements or compounds or the release into water of any substance listed in paragraph 10 of Part 2 of this Schedule.

Part A(d) Recovering any compound of cadmium or mercury.

Part A(e) Unless falling within another section of this Schedule, any manufacturing activity involving the use of mercury or cadmium or any compound of either element or which may result in the release into air of either of those elements or their compounds.

Part A(f) Unless falling within another section of this Schedule, any activity, other than the combustion or incineration of carbonaceous material, which is likely to result in the release into the air of any acid-forming oxide of nitrogen.

Chapter 6, Other activities. Section 6.11 *Waste water treatment*

Part A(a) Independently operated treatment of waste water not covered by Directive 91/271/EEC and discharged by a Part A installation or Part A mobile plant (*provided that the main pollutant load originates from the activities covered by these BAT conclusions*).

Appendix 3: Techniques

1 Management techniques
- 1.1 EMS
- 1.2 Chemicals management plans
- 1.3 Process specification and quality control to reduce reworking
- 1.4 Benchmarking performance and environmental parameters
- 1.5 Process line optimisation
- 1.6 Real time process control

2 Installation design, construction and operation
- 2.1 Pollution prevention from unplanned releases - planning, design, construction and other systems
- 2.2 Storage of chemicals
- 2.3 Accident prevention and response procedures
- 2.4 Process line type and construction

3 General operational issues
- 3.1 Protection of workpieces and substrates - before and after treatment
- 3.1.1 Shortening storage time
- 3.1.2 Storage and transport conditions
- 3.1.3 Packaging
- 3.1.4 Corrosion prevention coating with oil or grease
- 3.2 Minimisation and optimisation of coatings from previous mechanical treatments - oil and grease
- 3.3 Jigging
- 3.4 Agitation of process solutions
- 3.5 Maintenance of plant and equipment

4 Utility inputs and their management
- 4.1 Energy Efficiency plans and audit
- 4.2 Management of incoming high voltage supplies and large current demands
- 4.3 Use of DC supply (with automated control for DC rectifiers)
- 4.4 Use of energy efficient equipment
- 4.5 Optimising process electrical efficiency
- 4.6 Heating of process solutions
- 4.7 Reducing heating losses from process solutions
- 4.8 Water cooling systems
- 4.9 Evaporation
- 4.10 Water supply (minimising use), treatment (e.g. ion exchange) and recycling /re-use
- 4.11 Control of water usage
- 4.12 Rinsing stages using recycled water

5 Process operations
- 5.1 Drag-in reduction
- 5.2 Drag-out reduction
- 5.2.1 Use of compatible chemicals
- 5.2.2 Reduction of drag-out - jig (rack processing)
- 5.2.3 Reduction of drag-out barrel processing
- 5.2.4 Properties of process solutions - effect on drag-out
- 5.2.5 Transition from drag-out draining to rinsing
- 5.3 Rinsing techniques and drag-out recovery
- 5.3.1 Evaporation as a requirement for drag-out recovery

7.10.3 Chromium-free conversion process
7.11 Chromic acid anodising
7.12 Phosphochromating (phosphating with chromium)
7.13 Substitution for mechanical polishing and buffering
7.14 Substitution and choices for degreasing
7.14.1 Mechanical pre-cleaning - centrifuging
7.14.2 Solvent degreasing
7.14.3 Chemical aqueous (soak) degreasing
7.14.4 Weak emulsion degreasing
7.14.5 Biological degreasing
7.14.6 Dry ice
7.14.7 Ultrasonic cleaning
7.14.8 Electrolytic cleaning with pH control
7.14.9 High performance degreasing systems
7.15 Other degreasing techniques
7.16 Substitution by alternative process

8 Common techniques for treating waters and aqueous solutions: feed-water, rinses, waste water treatment, process solutions and materials recovery

8.1 Filtration
8.10 Electro deionisation
8.11 Acid (resin) sorption or retardation
8.12 Ion exchange - liquid/liquid
8.13 Membrane filtration microfiltration (MF) ultrafiltration (UF) nanofiltration (NF)
8.14 Reverse Osmosis (RO)
8.15 Diffusion dialysis
8.16 Membrane electrolysis
8.17 Electrodialysis
8.2 Absorption techniques
8.3 Crystallisation
8.4 Atmospheric evaporation: natural and assisted (evaporators etc.)
8.5 Vacuum evaporation
8.6 Electrolysis - recovery of metals
8.7 Electrolysis - plating out
8.8 Electrolysis - oxidation
8.9 Ion-exchange resin

9 Process solution maintenance

9.1 Filtration of process solutions
9.2 Electrodialysis
9.3 Retardation (acid resin sorption)
9.4 Crystallisation of carbonates and metal sulphates
9.5 Anodising caustic etch recovery
9.6 Activated carbon treatment
9.7 Ion exchange purification of metallic contamination
9.8 Electrolysis - purification of process solution
9.9 Electrolysis - removal of surplus metal from process solutions
9.10 Electrolysis - reoxidation of breakdown products
9.11 Membrane electrolysis for chromium solution maintenance
9.12 Cleaning and regeneration of phosphate solutions
9.13 Maintenance of degreasing solutions
9.13.1 Cascade (multiple) use of degreasing solutions

9.13.2 Simple methods (including filtration, mechanical separation and gravity setting)
9.13.3 Static separator for degreasing baths
9.13.4 Biological degreasing regeneration
9.13.5 Centrifuging if degreasing baths
9.13.6 Membrane filtration of emulsifying degreasers (micro- or ultrafiltration)
9.13.7 Multistage maintenance of degreasing solutions
9.13.8 Maintenance of electrolytic degreasing process
9.14 Pickling
9.14.1 Measures for decreasing pickling acid consumption
9.14.2 Extension of the service life of picking solutions by diffusion analysis
9.14.3 Recovery of copper from pickling baths

10 Recovery of process metals

10.1 Electrolytic recovery
10.2 Ion exchange - recovery of precious metals from rinses
10.3 Chromating
10.4 Precipitation

11 Post-treatment activities - techniques relevant to the determination of BAT

11.1 Drying
11.2 De-embrittlement

12 Continuous coil - large scale steel coil

12.1 Using digital process control
12.2 Oil tight trays
12.3 Energy efficiency including
12.3.1 Energy efficient motors
12.3.2 Raising the conductivity of the electrolyte
12.4 Water efficiency including
12.4.1 Recycling of quench waters
12.4.2 Use of cascade rinse systems
12.5 Squeeze rolls
12.6 Electrolytic strip cleaning
12.7 Use of ultrafiltration systems to regenerate degreasing solution
12.8 Cascade (multiple) use of degreasing solutions
12.9 Control of the acid bath in the pickling section
12.10 Control and management of electrolyte consumption
12.11 Switching the polarisation of the electrodes in the electrolytic processes
12.12 Optimisation of the anode-cathode gap
12.13 Polishing the conductor roll
12.14 Using edge polishers
12.15 Using edge masks
12.16 Minimise use of oil by covered electrostatic oilers
12.17 Maintenance of process solutions including
12.17.1 Cleaning and recirculation of degreasing baths
12.17.2 Continuous filtering and re-use of the zinc bath
12.17.3 Continuous removal of iron and re-use of the zinc bath
12.17.4 Cleaning and regeneration of the phosphate bath
12.17.5 Cleaning and regeneration of the chromate bath
12.18 Control of emissions to air
12.18.1 Collection and scrubbing
12.18.2 Covered treatment baths

12.19 Recovery of residual materials from tanks

13 Printed circuit board processing

13.1 Manufacture of inner layers
13.2 Rinsing between steps
13.3 Electroless (autocatalytic) plating
13.4 Electroplating PCBs
13.5 Development of dry resist by sodium carbonate
13.6 Etching
13.7 Recycling of alkali etchants online with copper recovery (liquid/liquid ion exchange)
13.8 Resist stripping
13.9 Stripping of etch (tin) resist

14 Disposal of solutions

14.1 Solvent emissions from the application of solder mask

15 Waste water emission abatement techniques

15.1 Identification of problem flows
15.2 Elimination and/or separation of the individual pollutants at the point of generation
15.3 Separation of oils and greases (hydrocarbons) from waste water
15.4 Cyanide oxidation
15.5 Nitrite treatment
15.6 Chromate treatment
15.7 Flocculation and precipitation of metals
15.7.1 Hydroxide precipitation
15.7.2 Sulphide precipitation
15.7.3 Other flocculating agents
15.8 Complexing agents
15.9 Precipitation of anions
15.9.1 Fluoride precipitation
15.9.2 Phosphate precipitation
15.9.3 Sulphate precipitation
15.10 Final treatment prior to discharge
15.10.1 Sedimentation
15.10.2 Flotation
15.10.3 Filtration
15.11 Combining techniques
15.12 Zero discharge techniques
15.12.1 Thermal procedures including vacuum and infrared evaporators
15.12.2 Membrane technologies with physico-chemical processes including ultrafiltration and combined ultrafiltration with reverse osmosis
15.13 Monitoring, final control and discharge of waste waters

16 Waste management techniques

16.1 Generation and management of waste
16.2 Waste minimisation and avoidance
16.3 Reuse and recycling of waste
16.4 In-house electrolytic recovery

17 Air emission abatement techniques

17.1 Additives
17.2 Air extraction, lids and treatment techniques
17.3 Reduction of the volume of extracted air

17.4 Treatment of extracted air
17.5 Air extraction control techniques
17.6 Energy recovery from extracted air

Emerging Techniques – now established

Emerging techniques were presented in the FPIQ and discussed by the TWG at the kick-off meeting. It was agreed that the following are now considered to be established techniques in the STM sector:

- Separate treatment of nickel waste water for off-site metal recovery – nickel can be reprocessed. It was confirmed that this is an established technique and comments made that there are examples of sludge treatment for recovery of nickel in Germany.
- Process-integrated automated plating – these should be included as a technique. Comments were made by the TWG that the definition of 'automated' needs to be caveated as some manual input is still needed for automated processes.
- Substitution by chromium (III) conversion coatings for chromium (VI) conversion – it was confirmed by the TWG that this is an established technique.
- Applying plastic balls to the bath surface to limit evaporation (anodising and other processes) – this is a well-established process.
- Recirculating rinsing water from etching and surface treatment to surface treatment baths – it was confirmed that this is an established technique, but there can be issues with the final rinse. There was further discussion around the volume being constant in the surface treatment bath, recirculating of the solution and recycling drag out issues. A comment was made that not all water can be recirculated to maintain sufficient quality, but that the majority is recycled or recirculated.
- High Velocity Oxy Coating Process - replacement for hard chrome plating – comments were made that this is an established technique.
- FP7: Tartaric Sulphuric Acid Anodizing (TSAA): VALIDATETSAA (Validate of TSAA coating technology. Development of procedures and standards manual. Technical and economic study – this was confirmed to be a well-established technique.
- Laser stripping – established technique.
- Plasma nitriding – established in the UK, the SEA will provide further information about it.
- Use of aluminium hydroxide suspension for elimination of phosphates in wastewater treatment wherever such material is available - established technique.
- Medium temperature sealing systems for anodizing of aluminium -established technique.
- Use of spent treatment baths with high acidity or alkalinity for waste water neutralization – this is a well-established technique.

Future emerging techniques

- PCBs: Laser direct imaging
- PCBs: High density interconnects (HDI)

- PCBs: Embedded passives
- LIFE DIME project: Demonstration of an innovative technology for the minimisation of the environmental impact of metal finishing processes (LIFE16 ENV/ES/000410)
- Eco-innovation
- FP7: HIMMOVAL (High speed metallic material removal under acceptable surface integrity for rotating frame)
- FP7: EASYFORM (Laser-assisted metal spinning for an efficient and flexible processing of nickel- and titanium-alloys)
- FP7: AMAZE (Additive Manufacturing Aiming Towards Zero Waste and Efficient Production of High-Tech Metal Products)
- Purifying the hard chromating surface treatment baths from pollutants using ion exchangers and evaporators
- Recycling of pressed aluminium hydroxide sludge
- Combining Sig Sigma and Lean methodologies with wastewater batch treatment processes
- Wastewater treatment with electrolysis
- Single-stage separation of metals from wastewater
- LIFE EMPEREUR project: Use of emulsion pertraction to extend the lifetime of the passivating baths (LIFE03 ENV/NL/000476)