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Best Available Techniques
UK BAT

# UK Best Available Techniques

# Formal Draft:
# BAT Conclusions for the Batch Galvanizing Sector

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# Preface

## Status of the document

This document is the formal draft of the UK Best Available Techniques (BAT) and associated BAT Emission Limits (BAT-AELs) and Environmental Performance Levels (BAT-AEPLs) for the batch galvanizing sector.

It has been developed based on the outputs from the EU BREF process, which UK representatives participated in until 31 January 2020, along with comments and evidence provided by the UK BAT Ferrous Metals Processing (Batch Galvanizing) Technical Working Group (TWG). It uses evidence available from current industry practice, sector activities and regulatory submissions setting out relevant conclusions within a UK context.

The formal draft documents the consensus reached at the formal meeting of the TWG held 29th, 30th, 31st March and 25th May 2023. No alternative positions have been presented.

## UK BAT process

The UK BAT process was established in 2022 to organise an information exchange between UK Government, Devolved Administrations, Regulators, industry and interested third parties, e.g. environmental non-governmental organisations (NGOs) on BAT used to control industrial pollution. Technical Working Groups (TWGs) have been formed for each sector under review. They have worked in a collaborative forum to discuss and develop BATC for the United Kingdom.

The UK BAT Conclusions (BATCs) comprise a short description of each Best Available Technique identified, its applicability and where applicable associated emission or consumption levels.

These draft BATCs will be published for comment and public consultation. When the BATCs are approved it will be published as a statutory instrument and used as a basis for environmental permit conditions.

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# Scope of review

## Scope of the review under UK legislation

### In **England and Wales** under UK SI 2016 No.1154 The Environmental Permitting (England and Wales) Regulation 2016:

Schedule 1, Part 2, Chapter 2 Production and processing of metals, Section 2.1 Ferrous metals, Part A(2) (c) "Applying protective fused metal coatings with an input of more than 2 tonnes of crude steel per hour" (when it is carried out in batch galvanizing).

Schedule 1, Part 2, Chapter 2 Production and processing of metals, Section 2.3 Surface treating of metals and plastic materials, 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" (when it is carried out in batch galvanizing).

Note: Batch galvanizing is a Part A(2) activity in Section 2.1A(2)(c) above the 2 tonnes per hour threshold. Melting of zinc in conjunction with a batch galvanizing activity up to the 2 tonnes per hour threshold is a Part B activity in Section 2.2B(c). Therefore, the associated surface treatment activity is always a Part A(2) activity where the treatment vats are more than $30m^3$. It is not envisaged that a batch galvanizing activity which is not A(2) will melt more than the 20 tonnes per day of zinc needed to make this a Section 2.2 A(2)(a) activity.

### In **Scotland** under SSI 2012 No.360 The Pollution Prevention and Control (Scotland) Regulations 2012:

Schedule 1, Part 2, Chapter 2 Production and processing of metals, Section 2.1 Ferrous metals, Part A (g) "Applying protective fused metal coatings with an input of more than 2 tonnes of crude steel per hour" (when it is carried out in batch galvanizing).

Schedule 1, Part 2, Chapter 2 Production and processing of metals, Section 2.3 Surface treating of metals and plastics, Part A (a) "Surface treating metals and plastic materials using an electrolytic or chemical activity where the aggregated volume of the treatment vats exceeds $30m^3$" (when it is carried out in batch galvanizing).

### In **Northern Ireland** under Statutory Rules 2013 No. 160 The Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013:

Schedule 1, Part 2, Chapter 2 Production and processing of metals, Section 2.1 Ferrous metals, Part A (g) "Applying protective fused metal coatings with an input of more than 2 tonnes of crude steel per hour" (when it is carried out in batch galvanizing).

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Schedule 1, Part 2, Chapter 2 Production and processing of metals, Section 2.3 Surface treating of metals and plastics, 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 $30m^3$" (when it is carried out in batch galvanizing).

Note: A current version of the above-mentioned Regulations should be consulted as they may have been amended since these BAT Conclusions were published.

Whilst the above activity descriptions referring to the application of protective fused metal coatings, includes both hot dip coating (continuous galvanizing) and batch galvanizing, these BAT conclusions only concern batch galvanizing installations.

Batch galvanizing includes a number of pre-treatment and possibly post-treatment stages prior to, and following, the zinc coating step, some of these stages also fall within the legal definition of surface treatment. The BAT Conclusions listed within this document cover the entire batch galvanizing activity which includes all pre-treatment and post-treatment process stages.

Surface treating metals and plastic materials is defined in Section 2.3 of the above referenced legislation. However, there are some minor differences in the wording across the UK. These small differences in wording are not considered significant. It should be noted that process activities of batch galvanizing that might otherwise be deemed to be STM activities are included in these BAT conclusions, rather than the STM BAT conclusions.

The entire process of a batch galvanizing installation~~s~~ comes within scope of these BAT conclusions if either of the 2 thresholds are exceeded, that is:

- an input of more than 2 tonnes of crude steel per hour, or
- the volume of the treatment vats exceeds 30 $m^3$

Batch galvanizing installations operating below both of these thresholds are not within scope but may still be subject to regulation as a Part B activity.

## Associated activities included in the UK BAT batch galvanizing scope

Acid recovery, if directly associated with the activities covered by these BAT conclusions.

Combustion processes directly associated with the activities covered by these BAT conclusions provided that (i) the gaseous products of combustion are put into direct contact with material (such as the direct heating or direct drying of workpieces), or (ii) the radiant and/or conductive heat is transferred through a

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solid wall (indirect heating): - without using an intermediary heat transfer fluid (this includes heating of the galvanizing kettle).

Note: These types of combustion processes do not come within the definition of Large or Medium Combustion Plant.

## Activities excluded from the UK BAT batch galvanizing scope

These BAT conclusions do not cover the following:

a. Metal coating by thermal spraying.
b. Electroplating and electroless plating; this may be covered by the BAT conclusions for Surface Treatment of Metals and Plastics (STM).

# Other relevant BATC

Other BAT conclusions and reference documents which could be relevant for the activities covered by these BAT conclusions include the following:

a. Iron and Steel Production (IS)
b. Large Combustion Plants (LCP)
c. Surface Treatment of Metals and Plastics (STM)
d. Surface Treatment using Organic Solvents (STS)
e. Waste Treatment (WT)
f. Non-ferrous Metal Industries (NFM)
g. UK BATC, Ferrous Metals Processing (Forming) (FMP-F)

These BAT conclusions apply without prejudice to other relevant legislation, e.g. on the registration, evaluation, authorisation and restriction of chemicals (REACH), on classification, labelling and packaging (CLP).

# Links between UK legislation and EU directives

These draft BATCs cover the above batch galvanizing activities as defined in UK legislation based on Annex I of the Industrial Emissions Directive (2010/75/EU) facilitated through the European Union (Withdrawal) Act (2018 c. 16).

As they are based on the draft outputs from a process in which the UK was included until 31 January 2020, the references to Directives and associated sections of the final draft EU BATC in the draft EU BREF for the batch galvanizing sector have been retained. This is to ensure a clear line of sight to the technical background developed from UK evidence. The EU BAT conclusions, published on the 11 October 2022, have no legal basis in UK law.

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# Definitions

For the purposes of these BAT conclusions, the following general definitions apply.

## General terms:

Table 1: Definition of general terms

| Term used | Definition |
|---|---|
| Batch galvanizing | Discontinuous immersion of steel workpieces in a bath containing molten zinc to coat their surface with zinc. This also includes any directly associated pre- and post-treatment processes (e.g. degreasing and passivation). |
| Bottom dross | A reaction product of molten zinc with iron or with iron salts carried over from pickling or fluxing. This reaction product sinks to the bottom of the zinc bath. |
| Channelled emissions | Emissions of pollutants into the environment through any kind of duct, pipe, stack, etc. |
| Continuous measurement | Measurement using an automated measuring system permanently installed on site. |
| Crude steel | Crude steel has the same meaning as feedstock, expressed as tonnes per hour. |
| Existing plant | A plant that is not a new plant. |
| Feedstock | The quantity of iron and / or steel workpieces entering the batch galvanizing production process. |
| Flue-gas | The exhaust gas exiting a combustion unit. |
| Low fume flux | A low fume flux is one where most of the ammonium chloride content has been replaced with potassium chloride so that it releases far less fume during the dipping operation. The composition of a low fume flux is typically in the range of 60 % zinc chloride, 30 % potassium chloride and 10 % ammonium chloride. |
| Major plant upgrade | A major change in the design or technology of a plant with major adjustments or replacements of the process and/or abatement technique(s) and associated equipment. |
| Mass flow | The mass of a given substance or parameter which is emitted over a defined period of time. |
| New plant | A plant first permitted at the site of the installation following the publication of these BAT conclusions or a complete replacement of a plant following the publication of these BAT conclusions. |
| Other than normal operating conditions | Operating conditions, such as start-up and shut-down operations, leaks, malfunctions, momentary stoppages, and definitive cessation of operations. |

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| Term used | Definition |
|---|---|
| Periodic measurement | Measurement at specified time intervals using manual or automated methods. |
| Plant | All parts of an installation covered by the scope of these BAT conclusions and any other directly associated activities which have an effect on consumption and/or emissions. Plants may be new plants or existing plants. |
| Process chemicals | Substances and/or mixtures as defined in Article 3 of Regulation EC/1907/2006 and used in the process(es). |
| Recovery | Recovery as defined in Article 3(15) of Directive 2008/98/EC.<br>The recovery of spent acids includes their regeneration, reclamation and recycling. |
| Regalvanizing | The processing of used galvanized articles (e.g. highway guard rails) that are returned to be galvanized after long service periods. Processing of these articles requires additional process steps due to the presence of partly corroded surfaces or the need to remove any residual zinc coating. |
| Residue | Substance or object generated by the activities covered by the scope of these BAT conclusions as waste or by-product. |
| Sensitive receptor | Areas which need special protection, such as:<br>- residential areas<br>- areas where human activities are carried out (e.g. neighbouring workplaces, schools, day-care centres, recreational areas, hospitals or nursing homes). |
| Top dross | In hot dipping, the oxides formed on the surface of the molten zinc bath by reaction of iron and aluminium. |
| Valid hourly (or half-hourly) average | An hourly (or half-hourly) average is considered valid when there is no maintenance or malfunction of the automated measuring system. |
| Volatile substance | A substance capable of readily changing from a solid or liquid form to a vapour, having a high vapour pressure and a low boiling point (e.g. HCl). This includes volatile organic compounds as defined in Article 3(45) of Directive 2010/75/EU. |
| Workpiece(s) | Any iron or steel article(s) entering the batch galvanizing production process. |
| Zinc ash | A mixture comprising zinc metal, zinc oxide and zinc chloride that is formed on the surface of the molten zinc bath. |

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## Pollutants and parameters:

Table 2: Pollutants and parameters

| **Term used** | **Definition** |
|---|---|
| CO | Carbon monoxide. |
| Dust | Total particulate matter (in air). |
| HCl | Hydrogen chloride. |
| $NH_3$ | Ammonia. |
| $NO_X$ | The sum of nitrogen monoxide (NO) and nitrogen dioxide ($NO_2$), expressed as $NO_2$. |
| $SO_2$ | Sulphur dioxide. |
| Zn | The sum of zinc and its compounds, dissolved or bound to particles, expressed as Zn. |

## Acronyms:

Table 3: Acronyms

| **Acronym** | **Definition** |
|---|---|
| BG | Batch galvanizing |
| CMS | Chemicals management system |
| EMS | Environmental management system |
| FMP | Ferrous metals processing |
| OTNOC | Other than normal operating conditions |
| SCR | Selective catalytic reduction |

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# General considerations

The techniques listed and described in these BAT conclusions are neither prescriptive nor exhaustive. Other techniques may be used that ensure at least an equivalent level of environmental protection.

Unless otherwise stated, the BAT conclusions are generally applicable.

# Emission levels associated with the best available techniques (BAT-AELs) and indicative emission levels for emissions to air

It is important to ensure that any BAT-AEL and indicative emission level is expressed in a manner that allows consistent measurement and comparisons. This is achieved by defining the reference conditions under which monitoring should be undertaken. Emission levels associated with the best available techniques (BAT-AELs) and indicative emission levels for emissions to air given in these BAT conclusions refer to concentrations (mass of emitted substances per volume of waste gas) under the following standard conditions: dry gas at a temperature of 273.15 K and a pressure of 101.3 kPa and expressed in $mg/Nm^3$.

The reference oxygen levels used to express BAT-AELs and indicative emission levels in these BAT conclusions are shown in the table below.

Table 4: Reference oxygen levels.

| **Source of emissions** | **Reference oxygen level ($O_R$)** |
|---|---|
| Combustion processes associated with:<br>- heating / drying of workpieces<br>- heating of the galvanizing kettle | 3 dry vol-% |
| All other sources | No correction for the oxygen level |

For the cases where a reference oxygen level is given, the equation for calculating the emission concentration at the reference oxygen level is:

$$E_R = \frac{(21 - O_R)}{(21 - O_M)} \times E_M$$

where:

$E_R$: emission concentration at the reference oxygen level $O_R$

$O_R$: reference oxygen level in vol-%

$E_M$: measured emission concentration

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$O_M$: measured oxygen level in vol-%

For averaging periods of BAT-AELs for emissions to air, the following definitions apply.

Table 5: Averaging periods of BAT-AELs for emissions to air

| Type of measurement | Averaging period | Definition |
|---|---|---|
| Continuous | Daily average | Average over a period of one day based on valid hourly or half-hourly averages. |
| Periodic | Average over the sampling period | Average value of three consecutive measurements of at least 30 minutes each ([1]) |

[1] For any parameter where, due to sampling or analytical limitations and/or due to operational conditions, a 30-minute sampling/measurement and/or an average of three consecutive measurements is inappropriate, a more representative sampling/measurement procedure may be employed.

When the waste gases of two or more sources (e.g. furnaces) are discharged through a common stack, the BAT-AELs apply to the combined discharge from the stack.

# Other environmental performance levels associated with the best available techniques (BAT-AEPLs)

## BAT-AEPLs for specific energy consumption (energy efficiency)

The BAT-AEPLs for specific energy consumption refer to yearly averages calculated annually using the following equation:

$$\text{specific energy consumption} = \frac{\text{energy consumption}}{\text{input}}$$

where:

energy consumption: total amount of heat (generated from primary energy sources) and electricity consumed by the relevant process(es), expressed in MJ/year or kWh/year; and

input: total throughput of workpieces processed, expressed in tonnes/year.

In the case of the heating of workpieces, the energy consumption corresponds to the total amount of heat (generated from primary energy sources) and electricity consumed by all furnaces in the relevant process(es).

## BAT-AEPLs for specific material consumption (pickling acid)

The BAT-AEPLs for specific material consumption refer to rolling averages calculated annually over 3 years calculated using the following equation:

$$\text{specific material consumption} = \frac{\text{material consumption}}{\text{input}}$$

where:

material consumption: 3-year rolling average of total amount of material consumed by the relevant process(es), expressed in kg/year; and

input: 3-year rolling average of total throughput of workpieces processed, expressed in tonnes/year.

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# BAT conclusions - general

This section captures those overarching BAT Conclusions which are associated with best practice and good environmental leadership for industrial processes.

## BAT 1: Environmental management system

To improve and maintain overall environmental performance, BAT is to elaborate and implement an environmental management system (EMS) that incorporates all of the following features:

a. management commitment, leadership, and accountability, including senior management, for the implementation of an effective EMS;
b. an analysis that includes the organisation's context, the needs and expectations of interested parties, and the characteristics of the installation that are associated with possible risks for the environment including human health; as well as the applicable legal requirements relating to the environment;
c. development of an environmental policy that includes the continuous improvement of the environmental performance of the installation;
d. establishing objectives and performance indicators in relation to the significant environmental aspects, including safeguarding compliance with applicable legal requirements;
e. planning and implementing the necessary procedures and actions (including corrective and preventive actions where needed), to achieve the environmental objectives and avoid environmental risks;
f. determination of structures, roles and responsibilities in relation to the environmental aspects and objectives including the provision of the financial and human resources needed;
g. ensuring the necessary competence and awareness of staff whose work may affect the environmental performance of the installation (e.g. by providing information and training);
h. internal and external communication;
i. fostering employee involvement in good environmental management practices;
j. establishing and maintaining a management manual, written procedures to control activities with significant environmental impact, and records that demonstrate compliance and record non-compliances;
k. effective operational planning and process control;
l. implementation of appropriate maintenance programmes;
m. emergency preparedness and response protocols, including the prevention and/or mitigation of the adverse (environmental) impacts of emergency situations;
n. when (re)designing a (new) installation or a part thereof, consideration of its environmental impacts throughout its life, which includes construction, maintenance, operation and decommissioning;
o. implementation of a monitoring and measurement programme;
p. application of sectoral benchmarking on a regular basis;
q. periodic internal auditing and independent external auditing in order to assess the environmental performance and to determine whether or

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not the EMS conforms to planned arrangements and has been properly implemented and maintained;

r. evaluation of causes of non-conformities, implementation of corrective actions in response to nonconformities, review of the effectiveness of corrective actions, and determination of whether similar nonconformities exist or could potentially occur;
s. periodic review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness;
t. following and taking into account the development of cleaner techniques.

Specifically for the batch galvanizing sector, BAT is to also incorporate the following features in the EMS:

u. an inventory of process chemicals used, waste and waste gas streams (see BAT 2);
v. a chemicals management system (see BAT 3);
w. an OTNOC management plan (see BAT 4);
x. an energy efficiency plan (see BAT 8);
y. a water efficiency plan (see BAT 18);
z. a noise and vibration management plan (see BAT 29);
aa. a residues management plan (see BAT 19(a)).

Note: Certification to ISO14001 is not mandatory but is an example of an EMS consistent with this BAT.

### Applicability

The level of detail and the degree of formalisation of the EMS will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.

In this context, a batch galvanizing plant, which is not part of another installation, is likely to be a relatively small-scale simple installation.

## BAT 2: Inventory of inputs and outputs

To facilitate the reduction of waste and of emissions to air, BAT is to establish, maintain and regularly review (including when a significant change occurs) an inventory of process chemicals used and of waste and waste gas streams, as part of the EMS (see BAT 1), that incorporates all of the following features:

a. Information about the production processes, including:
    i. simplified process flow sheets that show the origin of the emissions;
    ii. descriptions of process-integrated techniques and waste gas treatment at source including their performances.
b. Information about the characteristics of waste streams, such as the average values and variability of composition and quantity.

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c. Information about the quantity and characteristics of the process chemicals used:
   i. the identity and the characteristics of process chemicals, including properties with adverse effects on the environment and/or human health;
   ii. the quantities of process chemicals used and the location of their use.
d. Information about the characteristics of the waste gas streams, such as:
   i. average values and variability of flow and temperature;
   ii. average concentration and mass flow values of relevant substances (e.g. dust, $NO_X$, $SO_2$, CO, metals, acids) and their variability;
   iii. presence of other substances that may affect the waste gas treatment system (e.g. oxygen, nitrogen, water vapour) or plant safety (e.g. hydrogen).

Note: ISO 14031 gives guidance on the design and use of environmental performance evaluation (EPE) within an organisation.

### Applicability

The level of detail of the inventory will generally be related to the nature, scale and complexity of the plant, and the range of environmental impacts it may have.

## BAT 3: Chemicals management system

To improve the overall environmental performance, BAT is to elaborate and implement a chemicals management system (CMS) as part of the EMS (see BAT 1) that incorporates all the following features:

a. A policy to reduce the consumption and risks of process chemicals, including a procurement policy to select less harmful process chemicals and their suppliers with the aim of minimising the use and risks of hazardous substances and avoiding the procurement of an excess amount of process chemicals. The selection of process chemicals may consider:
   i. their eliminability, their eco-toxicity and their potential to be released into the environment in order to reduce emissions to the environment;
   ii. the characterisation of the risks associated with the process chemicals, based on the chemicals' hazards statement, pathways through the plant, potential release, and level of exposure;
   iii. the regular (e.g. annual) analysis of the potential for substitution to identify potentially new available and safer alternatives to the use of hazardous substances (e.g. use of other process chemicals with no or lower environmental impacts, see BAT 5);

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iv. the anticipatory monitoring of regulatory changes related to hazardous chemicals and safeguarding compliance with applicable legal requirements.

The inventory of process chemicals (see BAT 2) may be used to support the selection of process chemicals.

b. Goals and action plans to avoid or reduce the use and risks of hazardous substances.
c. Development and implementation of procedures for the procurement, handling, storage, and use of process chemicals to prevent or reduce emissions to the environment.

Note: ISO 14031 gives guidance on the design and use of environmental performance evaluation (EPE) within an organisation.

### Applicability

Generally applicable, the level of detail of the CMS will generally be related to the nature, scale, and complexity of the plant.

## BAT 4: Other than normal operating conditions (OTNOC)

To reduce the frequency of the occurrence of OTNOC and to reduce emissions during OTNOC, BAT is to set up and implement a risk based OTNOC management plan as part of the EMS (see BAT 1) that includes all of the following elements:

a. identification of potential OTNOC (e.g. failure of equipment critical to the protection of the environment (‘critical equipment’)), of their root causes and of their potential consequences, and regular review and update of the list of identified OTNOC following the periodic assessment below;
b. reference to consideration of appropriate design of critical equipment (e.g. compartmentalisation of fabric filters – this is expected to be contained within the permit application);
c. set-up and implementation of an inspection and preventive maintenance plan for critical equipment (see BAT 1(l));
d. quantification/monitoring (i.e. estimating or, where possible, measuring) and recording of emissions during OTNOC and of associated circumstances;
e. periodic assessment of the emissions occurring during OTNOC (e.g. frequency of events, duration, amount of pollutants emitted) and implementation of corrective actions if necessary.

### Applicability

The level of detail of the OTNOC Management Plan will generally be related to the nature, scale and complexity of the plant.

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# BAT conclusions – process

This section captures BATC appropriate to the control of environmental impacts best controlled through good process control of the unit operations being used.

## BAT 5: Hazardous substances

To avoid the use of hexavalent chromium compounds in passivation, BAT is to use other metal-containing solutions (e.g. containing manganese, zinc, titanium fluoride, phosphates and/or molybdates) or organic polymer solutions (e.g. containing polyurethanes or polyesters).

### Applicability

Applicability may be restricted due to product specifications (e.g. surface quality, paintability, weldability, formability, corrosion resistance).

## BAT 6: Monitoring of consumption, residues and waste

BAT is to monitor at least once per year:

a. the yearly consumption of water, energy and materials,
b. the yearly amount of each type of residues generated and of each type of waste sent for recovery or disposal.

### Description

Monitoring can be performed by direct measurements, calculations or recording, e.g. using suitable meters or invoices. The monitoring is broken down to the most appropriate level (e.g. to process or plant level) and considers any significant changes in the plant.

## BAT 7: Monitor channelled emissions to air

BAT is to monitor channelled emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.

Table 6: Monitoring frequencies and standards of channelled emissions to air

| **Substance/ Parameter** | **Specific process(es)** | **Standard(s)** | **Minimum monitoring frequency (1)(2)** | **Monitoring associated with** |
|---|---|---|---|---|
| CO | Heating of the galvanizing kettle (3) | BS EN 15058 | Once every year | BAT 24 |

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| Substance/ Parameter | Specific process(es) | Standard(s) | Minimum monitoring frequency [1][2] | Monitoring associated with |
|---|---|---|---|---|
| $NO_X$ | Heating of the galvanizing kettle [3] | BS EN 14792 | Once every year | BAT 24 |
| $NO_X$ | Acid recovery acid by spray roasting or by evaporation | BS EN 14792 | Once every year | BAT 34 |
| Dust | Acid recovery acid by spray roasting or by evaporation | BS EN 13284-1 | Once every year | BAT 34 |
| Dust | Hot dipping after fluxing | BS EN 13284-1 | Once every year [4] | BAT 26 |
| Dust | Other activities e.g. shot blasting plant | BS EN 13284-1 | Once every year | BAT 13(a)<br>BAT 19(d) |
| Zinc (Zn) | Hot dipping after fluxing | BS EN 14385 | Once every year [4] | BAT 26 |
| HCl | Pickling and stripping with hydrochloric acid | BS EN 1911 | Once every year | BAT 25 |
| HCl | Acid recovery acid by spray roasting or by evaporation | BS EN 1911 | Once every year | BAT 34 |
| $SO_2$ | Acid recovery acid by spray roasting or by evaporation | BS EN 14791 | Once every year | BAT 34 |

[1] To the extent possible, the measurements are carried out at the highest expected emission state under normal operating conditions.

[2] If measurements are continuous, the following generic EN standards apply: BS EN 15267-1, BS EN 15267-2, BS EN 15267-3, BS EN 14181 and BS EN 17255-1.

[3] The monitoring does not apply when only electricity is used.

[4] If the emission levels are proven to be sufficiently stable, a lower monitoring frequency can be adopted but, in any case, at least once every 3 years.

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# BAT conclusions – resource efficiency

This section captures those BAT conclusions which reflect the measures required to improve and maintain process efficiency. These may include resource use, energy efficiency and waste management.

## BAT 8: Energy efficiency plan

To increase the overall energy efficiency of the plant, BAT is to use both techniques given below.

Table 7: Techniques to increase energy efficiency

| Technique | Description | Applicability |
|---|---|---|
| a. Energy efficiency plan and energy audits | · An energy efficiency plan is part of the EMS (see BAT 1) and entails defining and monitoring the specific energy consumption of the activity/processes (see BAT 6), setting key performance indicators on an annual basis (e.g. kWh/tonne of product) and planning the periodic improvement targets and related actions.<br>· Energy audits are carried out at least once a year to ensure that the objectives of the energy management plan are met. | The level of detail of the energy efficiency plan, of the energy audits and of the energy balance record will generally be related to the nature, scale and complexity of the plant and the types of energy sources used. |
| b. Energy balance record | Drawing up on an annual basis of an energy balance record which provides a breakdown of the energy consumption and generation (including energy export) by the type of energy source (e.g. electricity, natural gas, renewable energy, imported heat and/or cooling). This includes:<br>(i) defining the energy boundary of the processes<br>(ii) information on energy consumption in terms of delivered energy<br>(iii) information on energy exported from the plant<br>(iv) energy flow information (e.g. Sankey diagrams or energy balances) showing how the energy is used throughout the processes. | The level of detail of the energy efficiency plan, of the energy audits and of the energy balance record will generally be related to the nature, scale and complexity of the plant and the types of energy sources used. |

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## BAT 9: Energy efficiency of heating

To increase energy efficiency in heating (including the heating / drying of workpieces as well as heating of baths and galvanizing kettles), BAT is to use an appropriate combination of the techniques given below.

Table 8: Energy efficiency for heating

| **Technique** | **Description** | **Applicability** |
|---|---|---|
| a. Design and operation: optimum galvanizing kettle design | This includes techniques such as:<br>· Uniform heating of the galvanizing kettle walls (e.g. by using high-velocity burners or radiant design).<br>· Minimisation of heat losses from the furnace using insulated outer/inner walls (e.g. ceramic lining) | Only applicable to new plants and major plant upgrades. |
| b. Design and operation: optimum galvanizing kettle operation | This includes techniques such as:<br>Minimisation of heat losses from the galvanizing kettle, e.g. by using insulated covers during idle periods | Generally applicable |
| c. Design and operation: combustion optimisation | Measures taken to maximise the efficiency of energy conversion in the furnace while minimising emissions (in particular of CO). This is achieved by a combination of techniques including good design of the furnace, optimisation of the temperature (e.g. efficient mixing of the fuel and combustion air) and residence time in the combustion zone and use of furnace automation and control | Generally applicable |
| d. Heat recovery from flue-gases: drying of workpieces | The heat from flue-gases is used to dry the workpieces | Generally applicable |

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| Technique | Description | Applicability |
|---|---|---|
| e. Heat recovery from flue-gases: preheating of combustion air | Reuse of part of the heat recovered from the combustion flue-gas to preheat the air used in combustion.<br>This may be achieved for example by using regenerative or recuperative burners. A balance has to be achieved between maximising heat recovery from the flue-gas and minimising $NO_X$ emissions | Applicability to existing plants may be restricted by a lack of space for the installation of regenerative burners |
| f. Heat recovery from flue-gases: waste heat recovery boiler | The heat from hot flue-gases is used to generate hot water that is used in other processes (e.g. for heating pickling and fluxing baths), or for space heating | Applicability to existing plants may be restricted by a lack of space or a suitable hot water demand |

## BAT-associated environmental performance level (BAT-AEPL) for energy efficiency of heating

Table 9: BAT-associated environmental performance level (BAT-AEPL) for specific energy consumption in batch galvanizing

| Specific process(es) | Unit | BAT-AEPL (Yearly average) |
|---|---|---|
| Batch galvanizing | kWh/tonne | 300–800 ([1]) ([2]) ([3]) |

[1] The higher end of the BAT-AEPL range may be higher when centrifugation is used to remove the excess zinc and/or when the galvanizing bath temperature is higher than 500 °C.

[2] The higher end of the BAT-AEPL may be higher and up to 1,200 kWh/tonne for batch galvanizing plants operating at an average yearly production throughput below 150 tonne/$m^3$ of kettle volume.

[3] In the case of batch galvanizing plants producing mainly thin products (e.g. < 1.5 mm), the higher end of the BAT-AEPL range may be higher and up to 1,000 kWh/tonne.

The associated monitoring is given in BAT 6.

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## BAT 10: Material efficiency in degreasing

To increase material efficiency in degreasing and to reduce the generation of spent degreasing solution, BAT is to use a combination of the techniques given below.

Table 10: Techniques to increase material efficiency in degreasing

| Technique | Description | Applicability |
|---|---|---|
| a. Avoiding or reducing the need for degreasing: processing of feedstock with low oil and grease contamination | The processing of feedstock (workpieces) with low oil and grease contamination prolongs the lifetime of the degreasing solution | Applicability may be limited if the feedstock quality cannot be influenced |
| b. Degreasing optimisation: general techniques for increased degreasing efficiency | These include techniques such as:<br>· monitoring and optimising the temperature and the concentration of degreasing agents in the degreasing solution<br>· enhancing the effect of the degreasing solution on the workpieces (e.g. by moving the workpieces, agitating the degreasing solution or by using ultrasound to create cavitation of the solution on the surface to be degreased) | Generally applicable |
| c. Degreasing optimisation: minimisation of drag-out of degreasing solution | This includes techniques such as:<br>· allowing for a sufficient dripping time, e.g. by slow lifting of the workpieces | Generally applicable |
| d. Degreasing optimisation: reverse cascade degreasing | Degreasing is carried out in two or more baths in series where the workpieces are moved from the most contaminated degreasing bath to the cleanest | Generally applicable |
| e. Extending the lifetime of the degreasing baths: cleaning and reuse of the degreasing solution | Magnetic separation, oil separation (e.g. skimmers, discharge launders, weirs), micro- or ultrafiltration or biological treatment is used to clean the degreasing solution for reuse | Generally applicable |

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## BAT 11: Material efficiency in stripping

To prevent the generation of spent acids with high zinc and high iron concentrations or, where that is not practicable, to reduce their quantity sent for disposal, BAT is to carry out pickling separately from stripping.

### Description

Pickling and stripping are carried out in separate tanks to prevent the generation of spent acids with high zinc and high iron concentrations or to reduce their quantity sent for disposal.

### Applicability

Applicability to existing plants may be restricted by a lack of space if additional tanks for stripping are needed.

## BAT 12: Material efficiency in pickling (when pickling acid is heated)

To increase material efficiency in pickling and reduce the generation of spent pickling acid when pickling acid is heated, BAT is to use one of the techniques given below and not to use direct injection of steam.

Table 11: Techniques to increase material efficiency in heated pickling

| Technique | Description |
|---|---|
| a. Acid heating with heat exchangers | Corrosion-resistant heat exchanger coils are immersed in the pickling acid for indirect heating, e.g. with steam |
| b. Acid heating by submerged combustion | Combustion gases pass through the pickling acid, releasing the energy via direct heat transfer |

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## BAT 13: Material efficiency in pickling (minimising spent acid)

To increase material efficiency in pickling and reduce the generation of spent pickling acid, BAT is to use an appropriate combination of the techniques given below.

Table 12: Techniques to reduce the generation of spent pickling acid

| Technique | Description | Applicability |
|---|---|---|
| a. Avoiding or reducing the need for pickling: mechanical descaling | This includes techniques such as:<br>· shot blasting<br>· sanding<br>· brushing | Applicability may be restricted due to product specifications. |
| b. Pickling optimisation: rinsing after alkaline degreasing | Carry-over of alkaline degreasing solution to the pickling bath is reduced by rinsing the workpieces after degreasing | Applicability to existing plants may be restricted by a lack of space. |
| c. Pickling optimisation: general techniques for increased pickling efficiency | These include techniques such as:<br>· optimisation of the pickling temperature for maximising pickling rates while minimising emissions of acids<br>· optimisation of the pickling bath composition (e.g. acid and iron concentrations)<br>· optimisation of the pickling time to avoid over-pickling<br>· avoiding drastic changes in the pickling bath composition by frequently replenishing it with fresh acid. | Generally applicable |
| d. Pickling optimisation: cleaning of the pickling bath and reuse of free acid | A cleaning circuit, e.g. with filtration, is used to remove particles from the pickling acid followed by reclamation of the free acid via ion exchange, e.g. using resins. | Not applicable if cascade pickling (or similar) is used, as this results in very low levels of free acid. |

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| Technique | Description | Applicability |
|---|---|---|
| e. Pickling optimisation: minimisation of drag-out of pickling acid | This includes techniques such as:<br>· allowing for a sufficient dripping time, e.g. by slow lifting of the workpieces<br>· using vibrating wire rod coils | Generally applicable |
| f. Pickling optimisation: use of pickling inhibitors | Pickling inhibitors are added to the pickling acid to protect clean parts of the workpieces from over-pickling. | Not applicable to high-alloy steel.<br>Applicability may be restricted due to product specifications |
| g. Pickling optimisation: activated pickling in hydrochloric acid pickling | Pickling is carried out with a low hydrochloric acid concentration (i.e. around 4–6 wt-%) and a high iron concentration (i.e. around 120–180 g/l) at temperatures of 20–25°C. | Generally applicable |

## BAT- associated environmental performance level (BAT-AEPL) for material efficiency in pickling (minimising spent acid)

Table 13: BAT- associated environmental performance level (BAT-AEPL) for specific pickling acid consumption

| Pickling acid | Unit | BAT-AEPL (3-year average) ([1]) |
|---|---|---|
| Hydrochloric acid, 28 wt-% | kg/t | 13–30 ([2]) |

[1] 3-year rolling average reported annually.

[2] The higher end of the BAT-AEPL range may be higher and up to 50 kg/t when galvanizing mainly feedstock with a high specific surface area (e.g. thin products < 1.5 mm, tubes of wall thickness < 3 mm, spin galvanized products), when baskets are used or when regalvanizing is carried out (e.g. highway barriers).

The associated monitoring is given in BAT 6.

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## BAT 14: Material efficiency in fluxing

To increase material efficiency in fluxing and to reduce the quantity of spent fluxing solution sent for disposal, BAT is to use all of the techniques (a), (b) and (c), in combination with technique (d) or in combination with technique (e) given below.

Table 14: Techniques to increase material efficiency in fluxing

| **Technique** | **Description** | **Applicability** |
|---|---|---|
| a. Rinsing of workpieces after pickling | In batch galvanizing, carry-over of iron to the fluxing solution is reduced by rinsing workpieces after pickling. | Applicability to existing plants may be restricted by a lack of space. |
| b. Optimised fluxing operation | The chemical composition of the fluxing solution is monitored and adjusted frequently. The amount of fluxing agent used is reduced to the minimum level required to achieve the product specifications. | Generally applicable |
| c. Minimisation of drag-out of fluxing solutions | The drag-out of the fluxing solution is minimised by allowing enough time for it to drip off. | Generally applicable |
| d. Iron removal and reuse of the fluxing solution | Iron is removed from the fluxing solution by one of the following techniques:<br>· electrolytic oxidation<br>· oxidation using air or $H_2O_2$<br>· ion exchange.<br>After iron removal, the fluxing solution is reused. | Applicability to existing batch galvanizing plants may be restricted by a lack of space. |
| e. Recovery of salts from the spent fluxing solution for production of fluxing agents | Spent fluxing solution is used to recover the salts contained therein to produce fluxing agents. This may take place on site or off site. | Applicability may be restricted depending on the availability of a market. |

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## BAT 15: Material efficiency in hot dipping

To increase the material efficiency of hot dipping in batch galvanizing, and to reduce the generation of waste, BAT is to use all the techniques given below.

Table 15: Techniques to increase the material efficiency of hot dipping in batch galvanizing

| Technique | Description |
|---|---|
| a. Optimised dipping time | The dipping time is limited to the duration required to achieve the coating thickness specifications. |
| b. Slow withdrawal of workpieces from the bath | By withdrawing the galvanized workpieces slowly from the galvanizing kettle, the drain-off is improved and zinc splashes are reduced. |
| c. Reduction of the generation of bottom dross | The generation of bottom dross is reduced, e.g. by sufficient rinsing after pickling, removing the iron from the fluxing solution (see BAT 14(d)), and using fluxing agents with a mild pickling effect, thus avoiding local overheating in the galvanizing kettle. |
| d. Prevention, collection, and reuse of zinc splashes in batch galvanizing | The generation of zinc splashes from the galvanizing kettle is reduced by minimising carry-over of the fluxing solution (see BAT 26(b)). Zinc splashes out of the kettle are collected and reused. The area surrounding the kettle is kept clean to reduce contamination of the splashes. |
| e. Reduction of the generation of zinc ash | The formation of zinc ash, i.e. zinc oxidation on the bath surface, is reduced for example by:<br>· sufficient drying of the workpieces before dipping<br>· avoiding unnecessary disturbances of the bath during production, including during skimming |

## BAT 16: Material efficiency in hot dipping of tubes

To increase material efficiency and to reduce the quantity of waste sent for disposal from blowing off excess zinc from galvanized tubes, BAT is to recover zinc-containing particles and to reuse them in the galvanizing kettle or to send them for zinc recovery.

## BAT 17: Material efficiency in spent acid recovery

To reduce the quantity of spent pickling acid sent for disposal, BAT is to recover spent pickling acids either on site or off site, or for spent pickling acids to be used as a secondary raw material. The neutralisation of spent pickling acids or the use of spent pickling acids for emulsion splitting is not BAT.

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### Description

Techniques to recover spent pickling acid include:

a. spray roasting or using fluidised bed reactors for the recovery of hydrochloric acid;
b. use of spent pickling acid as a secondary raw material (e.g. to produce iron chloride or pigments).

### Applicability

If the use of spent pickling acid as a secondary raw material is restricted by lack of market availability, then disposal of spent picking acid by neutralisation (usually off site) may exceptionally take place.

## BAT 18: Water efficiency plan

To optimise water consumption, to improve water recyclability and to reduce the volume of waste water generated, (see BAT 27). BAT is to use both techniques (a) and (b), and an appropriate combination of the techniques (c) to (e) given below.

Table 16: Techniques to optimise water consumption

| Technique | Description | Applicability |
|---|---|---|
| a. Water management plan and water audits | A water management plan and water audits are part of the EMS (see BAT 1) and include:<br>· flow diagrams and a water mass balance of the plant<br>· establishment of water efficiency objectives<br>· implementation of water optimisation techniques (e.g. control of water usage, water recycling, detection, and repair of leaks).<br>Water audits are carried out at least once every year to ensure that the objectives of the water management plan are met. | The level of detail of the water management plan and water audits will generally be related to the nature, scale and complexity of the plant. |

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| Technique | Description | Applicability |
|---|---|---|
| b. Segregation of water streams | Waste process water streams are segregated from surface waters. Based on the pollutant content in water streams, these can be recycled, treated or disposed of.<br>Waste water streams that can be recycled without treatment are segregated from waste water streams that require treatment. | Applicability to existing plants may be limited by the layout of the water collection system. |
| c. Reuse and/or recycling of water ([1]) | Water streams (e.g. surface water, process water, effluents from wet scrubbing or quench baths) are reused and/or recycled in closed or semi-closed circuits. | The degree of water reuse and/or recycling is limited by the water balance of the plant, the content of impurities and/or the characteristics of the water streams. |
| d. Reverse cascade rinsing | Rinsing is carried out in two or more baths in series where the workpieces are moved from the most contaminated rinsing bath to the cleanest | Applicability to existing plants may be restricted by a lack of space. |
| e. Recycling or reuse of rinsing water | Water from rinsing after pickling or degreasing is recycled/reused, if necessary after treatment, to the preceding process baths as make-up water, rinsing water or, if the acid concentration is sufficiently high, for acid recovery. | Generally applicable |

[1] Surface water should be harvested and used as process water where practicable.

## BAT 19: Reducing waste for disposal

To reduce the quantity of waste sent for disposal, BAT is to avoid the disposal of metals, metal oxides and oily sludge and hydroxide sludge by using technique (a) and an appropriate combination of techniques (b) to (d) given below, which may take place on site or off site.

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Table 17: Techniques to reduce the quantity of waste

| Technique | Description | Applicability |
| --- | --- | --- |
| a. Residues management plan | A residues management plan is part of the EMS (see BAT 1) and is a set of measures aiming to:<br>a. minimise the generation of residues,<br>b. optimise the reuse, recycling and/or recovery of residues, and;<br>c. ensure the proper disposal of waste. | The level of detail and the degree of formalisation of the residues management plan will generally be related to the nature, scale and complexity of the installation |
| b. Use of metallic scrap | Metallic scrap from mechanical processes is recycled. | Generally applicable |
| c. Use of oily sludge | Residual oily sludge, e.g. from degreasing, is dewatered to recover the oil contained therein for material or energy recovery. If the water content is low, the sludge can be directly used. | Generally applicable |
| d. Recovery and reuse of shot blast media | Where mechanical descaling is carried out by shot blasting, the shot blast media are separated from the scale and reused. | Generally applicable |

## BAT 20: Residues from hot dipping

To reduce the quantity of waste sent for disposal from hot dipping, BAT is to avoid the disposal of zinc-containing residues by using all of the techniques given below. This may take place on site or off site.

Table 18: Techniques to reduce the quantity of waste sent for disposal from hot dipping

| Technique | Description | Applicability |
| --- | --- | --- |
| a. Recycling of fabric filter dust | Dust from fabric filters containing ammonium chloride and zinc chloride is collected and reused, e.g. to produce fluxing agents. | Only applicable in hot dipping after fluxing. Applicability may be restricted depending on the availability of a market. |

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| Technique | Description | Applicability |
|---|---|---|
| b. Recycling of zinc ash and top dross | Metallic zinc is recovered from zinc ash and top dross by melting in recovery furnaces ([1]). The remaining zinc-containing residue is used, e.g. for zinc oxide production. | Generally applicable |
| c. Recycling of bottom dross | Bottom dross is used, e.g. in the non-ferrous metals industries to produce zinc. | Generally applicable |

[1]The operation of onsite zinc recovery furnaces is not part of these BAT conclusions.

## BAT 21: Recycling of zinc containing residues

To improve the recyclability and recovery potential of the zinc-containing residues from hot dipping (i.e. zinc ash, top dross, bottom dross, zinc splashes, and fabric filter dust) as well as to prevent or reduce the environmental risk associated with their storage, BAT is to store them separately from each other and from other residues on:

a. impermeable surfaces, in enclosed areas and in closed containers/bags for fabric filter dust;
b. impermeable surfaces and in covered areas protected from surface run-off water for all the other residue types above.

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# BAT conclusions – emissions

This section captures those BAT Conclusions where there are BAT-AELs which are not captured in other sections. It includes emissions to air, land and water as well as noise and odour.

## BAT 22: Emissions to air of dust from heating

To prevent or reduce dust emissions to air from heating, BAT is to use either electricity or fuels with low dust and ash content technique e.g. natural gas or liquefied petroleum gas.

Note: Electricity from renewable (fossil-free) sources will have lower indirect emissions of dust.

## BAT 23: Emissions to air of $SO_2$ from heating

To prevent or reduce $SO_2$ emissions to air from heating, BAT is to use either electricity or a fuel, or a combination of fuels, with low sulphur content.

### Description

Fuels with low sulphur content include e.g. natural gas or liquefied petroleum gas.

Note: Electricity from renewable (fossil-free) sources will have lower indirect emissions of $SO_2$.

## BAT 24: Emissions to air of $NO_X$ from heating

To prevent or reduce $NO_X$ emissions to air from heating while limiting CO emissions and the emissions of $NH_3$ from the use of SCR, BAT is to use either electricity or an appropriate combination of the techniques given below.

Table 19: Techniques to prevent or reduce $NO_X$ emissions to air from heating

| Technique | Description | Applicability |
|---|---|---|
| a. Reduction of generation of emissions: use of a fuel or a combination of fuels with low $NO_X$ formation potential. | Fuels with a low $NO_X$ formation potential, e.g. natural gas or liquefied petroleum gas. | Generally applicable |

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| Technique | Description | Applicability |
|---|---|---|
| b. Reduction of generation of emissions: furnace automation and control | The heating process is optimised by using a computer system controlling in real time key parameters such as furnace temperature, the air to fuel ratio and the furnace pressure. | Generally applicable |
| c. Reduction of generation of emissions: combustion optimisation | Measures taken to maximise the efficiency of energy conversion in the furnace while minimising emissions (in particular of CO). This is achieved by a combination of techniques including good design of the furnace, optimisation of the temperature (e.g. efficient mixing of the fuel and combustion air) and residence time in the combustion zone and use of furnace automation and control.<br>Generally used in combination with other techniques. | Generally applicable |
| d. Reduction of generation of emissions: low-$NO_X$ burners | The technique (including ultra-low-$NO_X$ burners) is based on the principles of reducing peak flame temperatures. The air/fuel mixing reduces the availability of oxygen and reduces the peak flame temperature, thus retarding the conversion of fuel-bound nitrogen to $NO_X$ and the formation of thermal $NO_X$, while maintaining high combustion efficiency. | Applicability may be restricted at existing plants by design and/or operational constraints. |
| e. Reduction of generation of emissions: flue-gas recirculation | Recirculation (external) of part of the flue-gas to the combustion chamber to replace part of the fresh combustion air, with the dual effect of lowering the temperature and limiting the $O_2$ content for nitrogen oxidation, thus limiting the $NO_X$ generation. It implies the supply of flue-gas from the furnace into the flame to reduce the oxygen content and therefore the temperature of the flame. | Applicability to existing plants may be restricted by a lack of space. |

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| Technique | Description | Applicability |
|---|---|---|
| f. Reduction of generation of emissions: limiting the temperature of air preheating | Limiting the air preheating temperature leads to a decrease of the concentration of $NO_X$ emissions. A balance has to be achieved between maximising heat recovery from the flue-gas and minimising $NO_X$ emissions. | May not be applicable in the case of furnaces equipped with radiant tubes burners. |
| g. Waste gas treatment: selective catalytic reduction (SCR) | The SCR technique is based on the reduction of $NO_X$ to nitrogen in a catalytic bed by reaction with urea or ammonia at an optimum operating temperature of around 300–450°C. Several layers of catalyst may be applied. A higher $NO_X$ reduction is achieved with the use of several catalyst layers. | Applicability to existing plants may be restricted by a lack of space. |
| h. Waste gas treatment: optimisation of the SCR design and operation | Optimisation of the reagent to $NO_X$ ratio over the cross-section of the furnace or duct, of the size of the reagent drops and of the temperature window in which the reagent is injected. | Only applicable where SCR is used for the reduction of $NO_X$ emissions. |

Note: Electricity from renewable (fossil-free) sources will have lower indirect emissions of $NO_X$.

## BAT-associated emission level (BAT-AEL) for emissions to air of $NO_X$ from heating

Table 20: BAT-associated emission level (BAT-AEL) for channelled $NO_X$ emissions to air and indicative emission level for channelled CO emissions to air from heating the galvanizing kettle in batch galvanizing

| Parameter | Unit | BAT-AEL (Daily average ([1]) or average over the sampling period) | Indicative emission level (Daily average ([1]) or average over the sampling period) |
|---|---|---|---|
| $NO_X$ | $mg/Nm^3$ | 70–300 | No indicative level |
| CO | $mg/Nm^3$ | No BAT-AEL | 10–100 |

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[1] If continuous monitoring is required the daily average will be the required averaging period.

The associated monitoring is given in BAT 7.

## BAT 25: Emissions to air from pickling and stripping

To reduce emissions of HCl to air from pickling and stripping in batch galvanizing, BAT is to control the operating parameters (i.e. temperature and acid concentration in the bath) and to use the techniques given below as follows:

- Where the bath temperature and HCl concentration is within the ranges set out in technique (d), then technique (d) either alone or in combination with technique (b) may be used.
- In all other circumstances, technique (a) or (b) in combination with technique (c) shall be used.

Table 21: Techniques to reduce emissions of HCl to air from pickling and stripping

| Technique | Description | Applicability |
|---|---|---|
| a. Collection of emissions: enclosed pretreatment section with extraction | The entire pretreatment section (e.g. degreasing, pickling, fluxing) is encapsulated and the fumes are extracted from the enclosure. | Only applicable to new plants and major plant upgrades |
| b. Collection of emissions: extraction by lateral hood or lip extraction | Acid fumes from the pickling tanks are extracted using lateral hoods or lip extraction at the edge of the pickling tanks. This may also include emissions from degreasing tanks. | Applicability in existing plants may be restricted by a lack of space |
| c. Waste gas treatment: wet scrubbing followed by a demister | The removal of gaseous or particulate pollutants from a gas stream via mass transfer to a liquid solvent, often water or an aqueous solution. It may involve a chemical reaction (e.g. in an acid or alkaline scrubber). In some cases, the compounds may be recovered from the solvent. | Generally applicable |

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| Technique | Description | Applicability |
|---|---|---|
| d. Reduction of generation of emissions: restricted operating range for hydrochloric acid open pickling baths | Hydrochloric acid baths are strictly operated within the temperature and HCl concentration range determined by the following conditions:<br>a) 4°C < T < (80 – 4w)°C;<br>b) 2 wt-% < w < (20 – T/4) wt-%,<br>where:<br>• T is the pickling acid temperature expressed in °C, and;<br>• w is the HCl concentration expressed in wt-%.<br>The bath temperature is measured at least once every day. The HCl concentration in the bath is measured every time fresh acid is replenished and, in any case, at least once every week. To limit evaporation, movement of air across the bath surfaces (e.g. due to ventilation) is minimised.<br>Tanks are covered when not in use. | Generally applicable |

## BAT-associated emission level (BAT-AEL) for emissions to air from pickling and stripping

Table 22: BAT-associated emission level (BAT-AEL) for channelled HCl emissions to air from pickling and stripping with hydrochloric acid in batch galvanizing

| Parameter | Unit | **BAT-AEL** (Daily average or average over the sampling period) |
|---|---|---|
| HCl | $mg/Nm^3$ | < 2 – 6 ([1])([2]) |

[1] BAT-AEL does not apply when technique (d) alone is used.

[2] Where technique (d) is used alone or in combination with technique (b), periodic monitoring of the HCl concentration in the gaseous phase above the pickling bath will be required to ensure compliance with relevant Health and Safety occupational health standards.

The associated monitoring is given in BAT 7.

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## BAT 26: Emissions to air from hot dipping

To reduce emissions to air of dust and zinc from hot dipping after fluxing, BAT is to reduce the generation of emissions by using:

- technique (b), and
- either technique (a) and/or technique (e), and
- either technique (c) or technique (d), where technique (d) should have priority over technique (c)

Table 23: Techniques to reduce emissions to air of dust and zinc from hot dipping after fluxing

| Technique | Description | Applicability |
|---|---|---|
| a. Reduction of generation of emissions: low-fume flux | Ammonium chloride in fluxing agents is partly substituted with other alkali chlorides (e.g. potassium chloride) to reduce dust formation. | Applicability may be restricted due to product specifications. |
| b. Reduction of generation of emissions: minimisation of carry-over of the fluxing solution | This includes techniques such as:<br>· allowing enough time for the fluxing solution to drip off (BAT 14(c))<br>· drying before dipping. | Generally applicable |
| c. Collection of emissions: air extraction as close as possible to the source | Air from the kettle is extracted, for example using lateral hood or lip extraction. | Generally applicable |
| d. Collection of emissions: enclosed kettle combined with air extraction | Hot dipping is carried out in an enclosed kettle and air is extracted. | Applicability to existing plants may be limited where enclosure interferes with an existing transport system for workpieces in batch galvanizing. |
| e. Waste gas treatment: fabric filter | Fabric filters, often referred to as bag filters, are constructed from porous woven or felted fabric through which gases are passed to remove particles. The use of a fabric filter requires the selection of a fabric suitable for the characteristics of the waste gas and the maximum operating temperature. | Generally applicable |

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## BAT-associated emission level (BAT-AEL) for emissions to air from hot dipping

Table 24: BAT-associated emission level (BAT-AEL) for channelled dust emissions to air from hot dipping after fluxing in batch galvanizing

| **Parameter** | **Unit** | **BAT-AEL** (Daily average or average over the sampling period) |
|---|---|---|
| Dust | $mg/Nm^3$ | < 2–5 ([1]) |

[1] The upper end of the range may be increased to 10 $mg/Nm^3$ in the circumstances where a low fume flux is used without a fabric filter in an existing plant provided that the mass flow is less than 200 g/hr.

The associated monitoring is given in BAT 7.

# BAT 27: Emissions to water

It is not BAT to discharge waste water from the batch galvanizing process.

## Description

Only liquid residues (e.g. spent pickling acid, spent degreasing solutions and spent fluxing solutions) are generated. These residues are collected. They are appropriately treated for recycling or recovery and/or sent for disposal (see BAT 17 and BAT 22). Surface water is segregated from process waste water, see BAT 18(b).

Note: Whilst the discharge of surface water which may be contaminated is not part of these BAT conclusions, risks associated with the discharge of surface water may need to be assessed and where necessary, controls put in place.

# BAT 28: Emissions to soil and groundwater

To prevent or reduce emissions to soil and groundwater, BAT is to use all the techniques given below.

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Table 25: Techniques to prevent or reduce emissions to soil and groundwater

| Technique | Description | Applicability |
|---|---|---|
| a. Set-up and implementation of a plan for the prevention and control of leaks and spillages | A plan for the prevention and control of leaks and spillages is part of the EMS (see BAT 1) and includes, but is not limited to:<br>· site incident plans for small and large spillages<br>· identification of the roles and responsibilities of persons involved<br>· ensuring staff are environmentally aware and trained to prevent and deal with spillage incidents<br>· identification of areas at risk of spillage and/or leaks of hazardous materials or resultant contaminated materials and ranking them according to the risk<br>· identification of suitable spillage containment and clean-up equipment and regularly ensuring it is available, in good working order and close to points where these incidents may occur<br>· waste management guidelines for dealing with waste arising from spillage control<br>· regular (at least on an annual basis) inspections of storage and handling areas, testing and calibration of leak detection equipment and prompt repair of leaks from valves, glands, flanges, etc. | The level of detail of the plan will generally be related to the nature, scale and complexity of the plant, as well as to the type and quantity of liquids used. |
| b. Use of oil-tight trays or cellars | Hydraulic stations and oil- or grease-lubricated equipment are situated in oil-tight trays or cellars. | Generally applicable |
| c. Prevention and handling of acid spillages and leaks | Storage tanks for both fresh and spent acid are equipped with sealed secondary containment protected with an acid-resistant coating which is regularly inspected for potential damage and cracks. Loading and unloading areas for the acids are designed in such a way that any potential spillages and leaks are contained and sent to off-site treatment. | Generally applicable |

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## BAT 29: Noise and Vibration

To prevent or, where that is not practicable, to minimise emissions of noise and vibration, BAT is to set up, implement and regularly review a noise and vibration management plan, as part of the EMS (see BAT 1) that includes all the following elements:

a. a protocol containing appropriate actions and timelines;
b. a protocol for conducting noise and vibration monitoring;
c. a protocol for response to identified noise and vibration events, e.g. equipment failure or complaints;
d. a noise and vibration minimisation programme designed to:
   i. identify the source(s) and sensitive receptors, both existing and potential, to include an annotated site plan;
   ii. measure/estimate noise and vibration exposures;
   iii. characterise the contributions of the sources;
   iv. rank order of the sources;
   v. implement prevention and/or minimisation measures.

### Applicability

The applicability is commonly restricted to cases where a noise or vibration impact at sensitive human receptors is expected and/or has been substantiated. However, if there is potential for an adverse noise impact on non-human receptors such as birds, bats, or other protected species or even farm animals, it may be necessary to minimise emissions of noise and vibration on those receptors.

## BAT 30: Noise and Vibration Abatement

To prevent or, where that is not practicable, to reduce noise and vibration emissions, BAT is to use one or a combination of the techniques given below.

Table 26: Techniques to prevent or reduce noise and vibration emissions

| Technique | Description | Applicability |
|---|---|---|
| a. Use of inherently quiet processes or low-noise equipment | This includes but not limited to techniques such as direct drive motors, low-noise compressors, pumps and fans, variable speed fans, and aerodynamic pipework layout. Opportunities to minimise noise at source should always be sought when equipment is reviewed/replaced. | Generally applicable |

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| Technique | Description | Applicability |
|---|---|---|
| b. Appropriate site layout to maximise screening and distances | Noise levels can be minimised by orienting equipment and processes with the highest noise impact away from the sensitive receptors, relocating the exits or entrances of the buildings, using buildings as a noise screen, and increasing the distance between the emitter and the receiver. The appropriate site layout may minimise the need for reversing goods vehicles | For existing plants, the relocation of equipment and the exits or entrances of the buildings may be more difficult due to a lack of space and/or excessive costs |
| c. Phasing of development and operational measures | These include but not limited to techniques such as:<br>· inspection and maintenance of equipment<br>· closing of doors and windows of enclosed areas, if possible<br>· equipment operation by experienced staff<br>· using sympathetic timings, e.g. avoiding noisy activities at night-time<br>· provisions for noise control, e.g. during production and maintenance activities, transport and handling of workpieces and materials<br>· careful placing instead of dropping of materials. | Generally applicable |
| d. Noise and vibration control equipment | This includes but not limited to techniques such as:<br>· noise reducers / rev engine limiters<br>· acoustic and vibrational insulation of equipment<br>· enclosure of noisy equipment (e.g. scarfing and grinding machines, air jets)<br>· building materials and elements with high sound insulation properties (e.g. for walls, roofs, windows, doors) | Applicability to existing plants may be more difficult due to a lack of space and/or excessive costs |

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| Technique | Description | Applicability |
|---|---|---|
| e. Noise abatement and maintenance | · Inserting obstacles between emitters and receivers (e.g. protection walls, bunding, noise barriers, embankments and buildings);<br>· Changing bearings before noise becomes excessive, maintaining relief valves to prevent chattering;<br>· Carrying out monitoring and/or measurement as an operational tool to assist with abatement. | Noise abatement is applicable to existing plants, as the design of new plants should make this technique unnecessary.<br><br>For existing plants, the insertion of obstacles may be more difficult due to a lack of space and/or excessive costs. |

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This draft document should not be used for reference until the final version is published (expected at the end of 2025).

# Sub sector BAT conclusions

This section captures BATC specific to those activities not commonly carried out as part of the batch galvanizing process, but which nevertheless could in principle form part of a batch galvanizing installation. Where relevant these will include the BAT-AEL.

## BAT 31: Material efficiency in stripping solution recovery

To reduce the quantity of spent stripping solutions with high zinc concentrations sent for disposal, BAT is to recover the spent stripping solutions and/or the zinc chloride ($ZnCl_2$) and ammonium chloride ($NH_4Cl$) contained therein on site or offsite.

### Description

Examples of techniques to recover spent stripping solutions with high zinc concentration include:

a. Zinc removal by ion exchange. The treated acid can be used in pickling, while the $ZnCl_2$- and $NH_4Cl$-containing solution resulting from the stripping of the ion-exchange resin can be used for fluxing.
b. Zinc removal by solvent extraction. The treated acid can be used in pickling, while the zinc-containing concentrate resulting from stripping and evaporation can be used for other purposes.

## BAT 32: Material efficiency in phosphating and passivation

To increase material efficiency and to reduce the quantity of waste sent for disposal from phosphating and passivation, BAT is to use one or both techniques given below.

Table 27: Techniques to increase the material efficiency in phosphating and passivation

| Technique | Description |
|---|---|
| a. Extending the lifetime of the treatment baths: cleaning and reuse of the phosphating or passivation solution | For example using-filtration to clean the phosphating or passivation solution for reuse. |
| b. Treatment optimisation: minimisation of drag-out of chemical solution | The drag-out of chemical solution is minimised, e.g. by allowing for sufficient dripping time for workpieces. |

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## BAT 33: Emissions to air from post treatment

To reduce emissions to air from chemical baths or tanks in post-treatment (i.e. phosphating and passivation), BAT is to collect the emissions by using technique (a) and in that case to treat the waste gas by using technique (b) and/or technique (c) given below.

Table 28: Techniques to reduce emissions to air from chemical baths or tanks

| Technique | Description | Applicability |
|---|---|---|
| a. Collection of emissions: air extraction as close as possible to the source | Emissions from the chemical storage tanks and chemical baths are captured, e.g. by using one or a combination of the following techniques:<br>· lateral hood or lip extraction;<br>· tanks equipped with moveable lids;<br>· enclosing hoods;<br>· placing the baths in enclosed areas.<br>The captured emissions are then extracted. | Only applicable when the treatment is carried out by spraying or when volatile substances are used. |
| b. Waste gas treatment: wet scrubbing | The removal of gaseous or particulate pollutants from a gas stream via mass transfer to a liquid solvent, often water or an aqueous solution. It may involve a chemical reaction (e.g. in an acid or alkaline scrubber). In some cases, the compounds may be recovered from the solvent. | Generally applicable |
| c. Waste gas treatment: demister | Demisters are filter devices that remove entrained liquid droplets from a gas stream. They consist of a woven structure of metal or plastic wires, with a high specific surface area. Through their momentum, small droplets present in the gas stream impinge against the wires and coalesce into bigger drops. | Generally applicable |

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## BAT 34: Emissions to air from recovery of spent acid

To reduce emissions to air of dust, HCl, $SO_2$, and $NO_X$ (while limiting CO emissions and where relevant the emissions of $NH_3$ from the use of SCR) from the on-site recovery of spent acid, BAT is to use a combination of the techniques given below.

Table 29: Techniques to reduce emissions to air from the recovery of spent acid

| Technique | Description | Applicability |
|---|---|---|
| a. Use of a fuel or a combination of fuels with low sulphur content and/or low $NO_X$ formation potential | Fuels with a low $NO_X$ formation potential, e.g. natural gas or liquefied petroleum gas. | Generally applicable |
| b. Combustion optimisation | Measures taken to maximise the efficiency of energy conversion in the furnace while minimising emissions (in particular of CO). This is achieved by a combination of techniques including good design of the furnace, optimisation of the temperature (e.g. efficient mixing of the fuel and combustion air) and residence time in the combustion zone and use of furnace automation and control.<br><br>Generally used in combination with other techniques. | Generally applicable |
| c. Low-$NO_X$ burners | The technique (including ultra-low-$NO_X$ burners) is based on the principles of reducing peak flame temperatures. The air/fuel mixing reduces the availability of oxygen and reduces the peak flame temperature, thus retarding the conversion of fuel-bound nitrogen to $NO_X$ and the formation of thermal $NO_X$, while maintaining high combustion efficiency. | Applicability may be restricted at existing plants by design and/or operational constraints. |
| d. Wet scrubbing followed by a demister | The removal of gaseous or particulate pollutants from a gas stream via mass transfer to a liquid solvent, often water or an aqueous solution. It may involve a chemical reaction (e.g. in an acid or alkaline scrubber). In some cases, the compounds may be recovered from the solvent. | Generally applicable |

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| Technique | Description | Applicability |
|---|---|---|
| e. Selective catalytic reduction (SCR) | The SCR technique is based on the reduction of $NO_X$ to nitrogen in a catalytic bed by reaction with urea or ammonia at an optimum operating temperature of around 300–450°C. Several layers of catalyst may be applied. A higher $NO_X$ reduction is achieved with the use of several catalyst layers. | Applicability to existing plants may be restricted by a lack of space. |
| f. Optimisation of the SCR design and operation | Optimisation of the reagent to $NO_X$ ratio over the cross-section of the furnace or duct, of the size of the reagent drops and of the temperature window in which the reagent is injected. | Only applicable where SCR is used for the reduction of $NO_X$ emissions. |

## BAT-associated emission levels (BAT-AELs) for emissions to air from recovery of spent acid

Table 30: BAT-associated emission levels (BAT-AELs) for channelled emissions of dust, HCl, $SO_2$ and $NO_X$ to air from the recovery of spent hydrochloric acid by spray roasting or by using fluidised bed reactors

| Parameter | Unit | BAT-AEL (Daily average or average over the sampling period) |
|---|---|---|
| Dust | $mg/Nm^3$ | < 2–15 |
| HCl | $mg/Nm^3$ | < 2–15 |
| $SO_2$ | $mg/Nm^3$ | < 10 |
| $NO_X$ | $mg/Nm^3$ | 50–180 |

The associated monitoring is given in BAT 7.

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