Commission Implementing Decision (EU) 2016/1032 of 13 June 2016 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the non-ferrous metals industries (notified under document C(2016) 3563) (Text with EEA relevance)

COMMISSION IMPLEMENTING DECISION (EU) 2016/1032

of 13 June 2016

establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the non-ferrous metals industries

(notified under document C(2016) 3563)

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)[1], and in particular Article 13(5) thereof,

Whereas:

(1) Best available techniques (BAT) conclusions are the reference for setting permit conditions for installations covered by Chapter II of Directive 2010/75/EU and competent authorities should set emission limit values which ensure that, under normal operating conditions, emissions do not exceed the emission levels associated with the best available techniques as laid down in the BAT conclusions.

(2) The forum composed of representatives of Member States, the industries concerned and non-governmental organisations promoting environmental protection, established by Commission Decision of 16 May 2011[2], provided the Commission on 4 December 2014 with its opinion on the proposed content of the BAT reference document for the non-ferrous metals industries. That opinion is publicly available.

(3) The BAT conclusions set out in the Annex to this Decision are the key element of that BAT reference document.

(4) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 75(1) of Directive 2010/75/EU,

HAS ADOPTED THIS DECISION:

Article 1

The best available techniques (BAT) conclusions for the non-ferrous metals industries, as set out in the Annex, are adopted.

Article 2

This Decision is addressed to the Member States.

Done at Brussels, 13 June 2016.

For the Commission

Karmenu VELLA

Member of the Commission

ANNEX

BAT CONCLUSIONS FOR THE NON-FERROUS METALS INDUSTRIES

SCOPE

These BAT conclusions concern certain activities specified in Sections 2.1, 2.5 and 6.8 of Annex I to Directive 2010/75/EU, namely:

— 2.1 : Metal ore (including sulphide ore) roasting or sintering;

— 2.5 : Processing of non-ferrous metals:

(a) production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes;

(b) melting, including the alloyage, of non-ferrous metals, including recovered products and operation of non-ferrous metal foundries, with a melting capacity exceeding 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals;

— 6.8 : Production of carbon (hard-burnt coal) or electrographite by means of incineration or graphitisation.

In particular, these BAT conclusions cover the following processes and activities:

- primary and secondary production of non-ferrous metals;
- the production of zinc oxide from fumes during the production of other metals;
- the production of nickel compounds from liquors during the production of a metal;
- the production of silicon-calcium (CaSi) and silicon (Si) in the same furnace as the production of ferro-silicon;
- the production of aluminium oxide from bauxite prior to the production of primary aluminium, where this is an integral part of the production of the metal;
- the recycling of aluminium salt slag;
- the production of carbon and/or graphite electrodes.

These BAT conclusions do not address the following activities or processes:

- Iron ore sintering. This is covered in the BAT conclusions for Iron and Steel production.
- The production of sulphuric acid based on SO_2 gases from non-ferrous metals production. This is covered in the BAT conclusions on Large Volume Inorganic Chemicals-Ammonia, Acids and Fertilisers.
- Foundries covered in the BAT conclusions for the Smitheries and Foundries Industry.

Other reference documents which could be of relevance for the activities covered in these BAT conclusions are the following.

Reference document	Subject
Energy Efficiency (ENE)	General aspects of energy efficiency
Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (CWW)	Waste water treatment techniques to reduce emissions of metals to water
Large Volume Inorganic Chemicals-Ammonia, Acids and Fertilisers (LVIC-AAF)	Sulphuric acid production

Industrial Cooling Systems (ICS)	Indirect cooling with water and/or air
Emissions from Storage (EFS)	Storage and handling of materials
Economics and Cross-media Effects (ECM)	Economics and cross-media effects of techniques
Monitoring of Emissions to Air and Water from IED installations (ROM)	Monitoring of emissions to air and water
Waste Treatments Industries (WT)	Waste handling and treatment
Large Combustion Plants (LCP)	Combustion plants generating steam and/or electricity
Surface Treatment Using Organic Solvents (STS)	Non-acid pickling
Surface Treatment of Metals and Plastics (STM)	Acid pickling

DEFINITIONS

For the purposes of these BAT conclusions, the following definitions apply:

Term used	Definition
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 on the existing foundations of the installation following the publication of these BAT conclusions
Existing plant	A plant that is not a new plant
Major upgrade	A major change in the design or technology of a plant and with major adjustments or replacements of the process units and associated equipment
Primary emissions	Emissions directly vented from the furnaces that are not spread to the areas surrounding the furnaces
Secondary emissions	Emissions escaping from the furnace lining or during operations such as charging or tapping and which are captured with a hood or enclosure (such as doghouse)
Primary production	Production of metals using ores and concentrates
Secondary production	Production of metals using residues and/or scraps, including remelting and alloying processes

Continuous measurement	Measurement using an 'automated measuring system' permanently installed on site for the continuous monitoring of emissions
Periodic measurement	Determination of a measurand (a particular quantity subject to measurement) at specified time intervals using manual or automated methods

GENERAL CONSIDERATIONS

Best Available Techniques

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 to air associated with BAT

Emission levels associated with the best available techniques (BAT-AELs) for emissions to air given in these BAT conclusions refer to standard conditions: dry gas at a temperature of 273,15 K, and a pressure of 101,3 kPa.

Averaging periods for emissions to air

For averaging periods for emissions to air, the following definitions apply.

Daily average	Average over a period of 24 hours of valid half-hourly or hourly averages obtained by continuous measurements
Average over the sampling period	Average value of three consecutive measurements of at least 30 minutes each, unless otherwise stated[a]

a For batch processes, the average of a representative number of measurements taken over the total batch time or the result of a measurement carried out over the total batch time can be used.

Averaging periods for emissions to water

For averaging periods for emissions to water, the following definition applies.

Daily average	Average over a sampling period of 24 hours taken as a flow-proportional composite sample (or as a time-proportional composite sample provided that sufficient flow stability is demonstrated)[a]

a For discontinuous flows, a different sampling procedure yielding representative results (e.g. spot sampling) can be used.

ACRONYMS

Term	Meaning
BaP	Benzo[*a*]pyrene
ESP	Electrostatic precipitator

I-TEQ	International toxic equivalency derived by applying international toxic equivalence factors, as defined in Annex VI, part 2 of Directive 2010/75/EU
NO_X	The sum of nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2
PCDD/F	Polychlorinated dibenzo-*p*-dioxins and dibenzofurans (17 congeners)
PAH	Polycyclic aromatic hydrocarbons
TVOC	Total volatile organic carbon; total volatile organic compounds which are measured by a flame ionisation detector (FID) and expressed as total carbon
VOC	Volatile organic compounds as defined in Article 3(45) of Directive 2010/75/EU

1.1. GENERAL BAT CONCLUSIONS

Any relevant process-specific BAT conclusions in Sections 1.2 to 1.9 apply in addition to the general BAT conclusions in this section.

1.1.1. **Environmental management systems (EMS)**

BAT 1. In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:

(a) commitment of the management, including senior management;

(b) definition of an environmental policy that includes the continuous improvement of the installation by the management;

(c) planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;

(d) implementation of procedures paying particular attention to:

- (i) structure and responsibility,
- (ii) recruitment, training, awareness and competence,
- (iii) communication,
- (iv) employee involvement,
- (v) documentation,
- (vi) effective process control,
- (vii) maintenance programmes,
- (viii) emergency preparedness and response,
- (ix) safeguarding compliance with environmental legislation;

(e) checking performance and taking corrective action, paying particular attention to:

  (i) monitoring and measurement (see also the Reference Report on Monitoring of emissions to Air and Water from IED installations-ROM),

  (ii) corrective and preventive action,

  (iii) maintenance of records,

  (iv) independent (where practicable) internal or external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;

(f) review of the EMS and its continuing suitability, adequacy and effectiveness by senior management;

(g) following the development of cleaner technologies;

(h) consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;

(i) application of sectoral benchmarking on a regular basis.

The establishment and implementation of an action plan on diffuse dust emissions (see BAT 6) and the application of a maintenance management system which especially addresses the performance of dust abatement systems (see BAT 4) are also a part of the EMS.
Applicability

The scope (e.g. level of detail) and nature of the EMS (e.g. standardised or non-standardised) will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.

1.1.2. **Energy management**

BAT 2. In order to use energy efficiently, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Energy efficiency management system (e.g. ISO 50001)	Generally applicable
b	Regenerative or recuperative burners	Generally applicable
c	Heat recovery (e.g. steam, hot water, hot air) from waste process heat	Only applicable for pyrometallurgical processes
d	Regenerative thermal oxidiser	Only applicable when the abatement of a combustible pollutant is required
e	Preheat the furnace charge, combustion air or fuel using the heat recovered from hot gases from the melting stage	Only applicable for roasting or smelting of sulphide ore/ concentrate and for other pyrometallurgical processes

f	Raise the temperature of the leaching liquors using steam or hot water from waste heat recovery	Only applicable for alumina or hydrometallurgical processes
g	Use hot gases from the launder as preheated combustion air	Only applicable for pyrometallurgical processes
h	Use oxygen-enriched air or pure oxygen in the burners to reduce energy consumption by allowing autogenous smelting or the complete combustion of carbonaceous material	Only applicable for furnaces that use raw materials containing sulphur or carbon
i	Dry concentrates and wet raw materials at low temperatures	Only applicable when drying is performed
j	Recover the chemical energy content of the carbon monoxide produced in an electric or shaft/blast furnace by using the exhaust gases as a fuel, after the removal of metals, in other production processes or to produce steam/hot water or electricity	Only applicable to exhaust gases with a CO content > 10 vol-%. Applicability is also influenced by the composition of the exhaust gas and the unavailability of a continuous flow (i.e. batch processes)
k	Recirculate the flue-gas back through an oxy-fuel burner to recover the energy contained in the total organic carbon present	Generally applicable
l	Suitable insulation for high temperature equipment such as steam and hot water pipes	Generally applicable
m	Use the heat generated from the production of sulphuric acid from sulphur dioxide to preheat gas directed to the sulphuric acid plant or to generate steam and/or hot water	Only applicable for non-ferrous metals plants including sulphuric acid or liquid SO_2 production
n	Use high efficiency electric motors equipped with variable-frequency drive, for equipment such as fans	Generally applicable
o	Use control systems that automatically activate the air extraction system or adjust	Generally applicable

	the extraction rate depending on actual emissions	

1.1.3. **Process control**

BAT 3. In order to improve overall environmental performance, BAT is to ensure stable process operation by using a process control system together with a combination of the techniques given below.

	Technique
a	Inspect and select input materials according to the process and the abatement techniques applied
b	Good mixing of the feed materials to achieve optimum conversion efficiency and reduce emissions and rejects
c	Feed weighing and metering systems
d	Processors to control material feed rate, critical process parameters and conditions including the alarm, combustion conditions and gas additions
e	On-line monitoring of the furnace temperature, furnace pressure and gas flow
f	Monitor the critical process parameters of the air emission abatement plant such as gas temperature, reagent metering, pressure drop, ESP current and voltage, scrubbing liquid flow and pH and gaseous components (e.g. O_2, CO, VOC)
g	Control dust and mercury in the exhaust gas before transfer to the sulphuric acid plant for plants including sulphuric acid or liquid SO_2 production
h	On-line monitoring of vibrations to detect blockages and possible equipment failure
i	On-line monitoring of the current, voltage and electrical contact temperatures in electrolytic processes
j	Temperature monitoring and control at melting and smelting furnaces to prevent the generation of metal and metal oxide fumes through overheating
k	Processor to control the reagents feeding and the performance of the waste water treatment plant, through on-line monitoring

	of temperature, turbidity, pH, conductivity and flow

BAT 4. In order to reduce channelled dust and metal emissions to air, BAT is to apply a maintenance management system which especially addresses the performance of dust abatement systems as part of the environmental management system (see BAT 1).

1.1.4. Diffuse emissions

1.1.4.1. *General approach for the prevention of diffuse emissions*

BAT 5. In order to prevent or, where this is not practicable, to reduce diffuse emissions to air and water, BAT is to collect diffuse emissions as much as possible nearest to the source and treat them.

BAT 6. In order to prevent or, where this is not practicable, to reduce diffuse dust emissions to air, BAT is to set up and implement an action plan on diffuse dust emissions, as part of the environmental management system (see BAT 1), that incorporates both of the following measures:

a. identify the most relevant diffuse dust emission sources (using e.g. EN 15445);

b. define and implement appropriate actions and techniques to prevent or reduce diffuse emissions over a given time frame.

1.1.4.2. *Diffuse emissions from the storage, handling and transport of raw materials*

BAT 7. In order to prevent diffuse emissions from the storage of raw materials, BAT is to use a combination of the techniques given below.

	Technique
a	Enclosed buildings or silos/bins for storing dust-forming materials such as concentrates, fluxes and fine materials
b	Covered storage of non-dust-forming materials such as concentrates, fluxes, solid fuels, bulk materials and coke and secondary materials that contain water-soluble organic compounds
c	Sealed packaging of dust-forming materials or secondary materials that contain water-soluble organic compounds
d	Covered bays for storing material which has been pelletised or agglomerated
e	Use water sprays and fog sprays with or without additives such as latex for dust-forming materials
f	Dust/gas extraction devices placed at the transfer and tipping points for dust-forming materials

g	Certified pressure vessels for storing chlorine gas or mixtures that contain chlorine
h	Tank construction materials that are resistant to the contained materials
i	Reliable leak detection systems and display of tank's level, with an alarm to prevent overfills
j	Store reactive materials in double-walled tanks or tanks placed in chemical-resistant bunds of the same capacity and use a storage area that is impermeable and resistant to the material stored
k	Design storage areas so that — any leaks from tanks and delivery systems are intercepted and contained in bunds that have a capacity capable of containing at least the volume of the largest storage tank within the bund; — delivery points are within the bund to collect any spilled material
l	Use inert gas blanketing for the storage of materials that react with air
m	Collect and treat emissions from storage with an abatement system designed to treat the compounds stored. Collect and treat before discharge any water that washes dust away.
n	Regular cleaning of the storage area and, when needed, moistening with water
o	Place the longitudinal axis of the heap parallel to the prevailing wind direction in the case of outdoor storage
p	Protective planting, windbreak fences or upwind mounts to lower the wind velocity in the case of outdoor storage
q	One heap instead of several where feasible in the case of outdoor storage
r	Use oil and solid interceptors for the drainage of open outdoor storage areas. Use of concreted areas that have kerbs or other containment devices for the storage of material that can release oil, such as swarf

Applicability

BAT 7. e is not applicable to processes that require dry materials or ores/concentrates that naturally contain sufficient humidity to prevent dust formation. The applicability may be limited in regions with water shortages or with very low temperatures

BAT 8. In order to prevent diffuse emissions from the handling and transport of raw materials, BAT is to use a combination of the techniques given below.

	Technique
a	Enclosed conveyors or pneumatic systems to transfer and handle dust-forming concentrates and fluxes and fine-grained material
b	Covered conveyors to handle non-dust-forming solid materials
c	Extraction of dust from delivery points, silo vents, pneumatic transfer systems and conveyor transfer points, and connection to a filtration system (for dust-forming materials)
d	Closed bags or drums to handle materials with dispersible or water-soluble components
e	Suitable containers to handle pelletised materials
f	Sprinkling to moisten the materials at handling points
g	Minimise transport distances
h	Reduce the drop height of conveyor belts, mechanical shovels or grabs
i	Adjust the speed of open belt conveyors (< 3,5 m/s)
j	Minimise the speed of descent or free fall height of the materials
k	Place transfer conveyors and pipelines in safe, open areas above ground so that leaks can be detected quickly and damage from vehicles and other equipment can be prevented. If buried pipelines are used for non-hazardous materials, document and mark their course and adopt safe excavation systems
l	Automatic resealing of delivery connections for handling liquid and liquefied gas
m	Back-vent displaced gases to the delivery vehicle to reduce emissions of VOC
n	Wash wheels and chassis of vehicles used to deliver or handle dusty materials

o	Use planned campaigns for road sweeping
p	Segregate incompatible materials (e.g. oxidising agents and organic materials)
q	Minimise material transfers between processes

Applicability

BAT 8.n. may not be applicable when ice could be formed.

1.1.4.3. *Diffuse emissions from metal production*

BAT 9. In order to prevent or, where this is not practicable, to reduce diffuse emissions from metal production, BAT is to optimise the efficiency of off-gas collection and treatment by using a combination of the techniques given below.

	Technique	**Applicability**
a	Thermal or mechanical pretreatment of secondary raw material to minimise organic contamination of the furnace feed	Generally applicable
b	Use a closed furnace with a properly designed dedusting system or seal the furnace and other process units with an adequate vent system	The applicability may be restricted by safety constraints (e.g. type/design of the furnace, risk of explosion)
c	Use a secondary hood for furnace operations such as charging and tapping	The applicability may be restricted by safety constraints (e.g. type/design of the furnace, risk of explosion)
d	Dust or fume collection where dusty material transfers take place (e.g. furnace charging and tapping points, covered launders)	Generally applicable
e	Optimise the design and operation of hooding and ductwork to capture fumes arising from the feed port and from hot metal, matte or slag tapping and transfers in covered launders	For existing plants, the applicability may be limited by space and plant configuration restrictions
f	Furnace/reactor enclosures such as ‘house-in-house’ or ‘doghouse’ for tapping and charging operations	For existing plants, the applicability may be limited by space and plant configuration restrictions

g	Optimise the off-gas flow from the furnace through computerised fluid dynamics studies and tracers	Generally applicable
h	Charging systems for semi-closed furnaces to add raw materials in small amounts	Generally applicable
i	Treat the collected emissions in an adequate abatement system	Generally applicable

1.1.5. **Monitoring of emissions to air**

BAT 10. BAT is to monitor the stack 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.

Parameter	**Monitoring associated with**	**Minimum monitoring frequency**	**Standard(s)**
Dust[b]	**Copper**: BAT 38, BAT 39, BAT 40, BAT 43, BAT 44, BAT 45 **Aluminium**: BAT 56, BAT 58, BAT 59, BAT 60, BAT 61, BAT 67, BAT 81, BAT 88 **Lead, Tin**: BAT 94, BAT 96, BAT 97 **Zinc, Cadmium**: BAT 119, BAT 122 **Precious metals**: BAT 140 **Ferro-alloys**: BAT 155, BAT 156, BAT 157, BAT 158 **Nickel, Cobalt**: BAT 171 **Other non-ferrous metals:** emissions from production stages such as raw material pretreatment, charging, smelting, melting and tapping	Continuous[a]	EN 13284-2

	Copper: BAT 37, BAT 38, BAT 40, BAT 41, BAT 42, BAT 43, BAT 44, BAT 45 **Aluminium**: BAT 56, BAT 58, BAT 59, BAT 60, BAT 61, BAT 66, BAT 67, BAT 68, BAT 80, BAT 81, BAT 82, BAT 88 **Lead, Tin**: BAT 94, BAT 95, BAT 96, BAT 97 **Zinc, Cadmium**: BAT 113, BAT 119, BAT 121, BAT 122, BAT 128, BAT 132 **Precious metals**: BAT 140 **Ferro-alloys**: BAT 154, BAT 155, BAT 156, BAT 157, BAT 158 **Nickel, Cobalt**: BAT 171 **Carbon/graphite**: BAT 178, BAT 179, BAT 180, BAT 181 **Other non-ferrous metals:** emissions from production stages such as raw material pretreatment, charging, smelting, melting and tapping	Once per year[a]	EN 13284-1
Antimony and its compounds, expressed as Sb	**Lead, Tin:** BAT 96, BAT 97	Once per year	EN 14385
Arsenic and its compounds, expressed as As	**Copper**: BAT 37, BAT 38, BAT 39, BAT 40, BAT 42, BAT 43, BAT 44, BAT 45 **Lead, Tin**: BAT 96, BAT 97 **Zinc**: BAT 122	Once per year	EN 14385

Cadmium and its compounds, expressed as Cd	**Copper**: BAT 37, BAT 38, BAT 39, BAT 40, BAT 41, BAT 42, BAT 43, BAT 44, BAT 45 **Lead, Tin**: BAT 94, BAT 95, BAT 96, BAT 97 **Zinc, Cadmium**: BAT 122, BAT 132 **Ferro-alloys**: BAT 156	Once per year	EN 14385
Chromium (VI)	**Ferro-alloys:** BAT 156	Once per year	No EN standard available
Copper and its compounds, expressed as Cu	**Copper**: BAT 37, BAT 38, BAT 39, BAT 40, BAT 42, BAT 43, BAT 44, BAT 45 **Lead, Tin**: BAT 96, BAT 97	Once per year	EN 14385
Nickel and its compounds, expressed as Ni	**Nickel, Cobalt:** BAT 172, BAT 173	Once per year	EN 14385
Lead and its compounds, expressed as Pb	**Copper**: BAT 37, BAT 38, BAT 39, BAT 40, BAT 41, BAT 42, BAT 43, BAT 44, BAT 45 **Lead, Tin**: BAT 94, BAT 95, BAT 96, BAT 97 **Ferro-alloys**: BAT 156	Once per year	EN 14385
Thallium and its compounds, expressed as Tl	**Ferro-alloys:** BAT 156	Once per year	EN 14385
Zinc and its compounds, expressed as Zn	**Zinc, Cadmium:** BAT 113, BAT 114, BAT 119, BAT 121, BAT 122, BAT 128, BAT 132	Once per year	EN 14385
Other metals, if relevant[c]	**Copper**: BAT 37, BAT 38, BAT 39, BAT 40, BAT 41, BAT 42,	Once per year	EN 14385

	BAT 43, BAT 44, BAT 45 **Lead, Tin**: BAT 94, BAT 95, BAT 96, BAT 97 **Zinc, Cadmium**: BAT 113, BAT 119, BAT 121, BAT 122, BAT 128, BAT 132 **Precious metals**: BAT 140 **Ferro-alloys**: BAT 154, BAT 155, BAT 156, BAT 157, BAT 158 **Nickel, Cobalt**: BAT 171 **Other non-ferrous metals**		
Mercury and its compounds, expressed as Hg	**Copper, Aluminium, Lead, Tin, Zinc, Cadmium, Ferro-alloys, Nickel, Cobalt, Other non-ferrous metals:** BAT 11	Continuous or once per year[a]	EN 14884 EN 13211
SO_2	**Copper**: BAT 49 **Aluminium**: BAT 60, BAT 69 **Lead, Tin**: BAT 100 **Precious metals**: BAT 142, BAT 143 **Nickel, Cobalt**: BAT 174 **Other non-ferrous metals**[fg]	Continuous or once per year[ad]	EN 14791
	Zinc, Cadmium: BAT 120	Continuous	
	Carbon/graphite: BAT 182	Once per year	
NO_X, expressed as NO_2	**Copper, Aluminium, Lead, Tin, FeSi, Si (pyrometallurgical processes)**: BAT 13 **Precious metals:** BAT 141 **Other non-ferrous metals**[g]	Continuous or once per year[a]	EN 14792
	Carbon/graphite	Once per year	

TVOC	**Copper**: BAT 46 **Aluminium**: BAT 83 **Lead, Tin**: BAT 98 **Zinc, Cadmium**: BAT 123 **Other non-ferrous metals**[h]	Continuous or once per year[a]	EN 12619
	Ferro-alloys: BAT 160 **Carbon/graphite:** BAT 183	Once per year	
Formaldehyde	**Carbon/graphite:** BAT 183	Once per year	No EN standard available
Phenol	**Carbon/graphite:** BAT 183	Once per year	No EN standard available
PCDD/F	**Copper**: BAT 48 **Aluminium**: BAT 83 **Lead, Tin**: BAT 99 **Zinc, Cadmium**: BAT 123 **Precious metals**: BAT 146 **Ferro-alloys**: BAT 159 **Other non-ferrous metals**[eg]	Once per year	EN 1948 parts 1, 2 and 3
H_2SO_4	**Copper**: BAT 50 **Zinc, Cadmium**: BAT 114	Once per year	No EN standard available
NH_3	**Aluminium**: BAT 89 **Precious metals**: BAT 145 **Nickel, Cobalt**: BAT 175	Once per year	No EN standard available
Benzo-[*a*]-pyrene	**Aluminium**: BAT 59, BAT 60, BAT 61 **Ferro-alloys**: BAT 160 **Carbon/graphite**: BAT 178, BAT 179, BAT 180, BAT 181	Once per year	ISO 11338-1 ISO 11338-2
Gaseous fluorides, expressed as HF	**Aluminium:** BAT 60, BAT 61, BAT 67	Continuous[a]	ISO 15713
	Aluminium: BAT 60, BAT 67, BAT 84	Once per year[a]	

	Zinc, Cadmium: BAT 124		
Total fluorides	**Aluminium:** BAT 60, BAT 67	Once per year	No EN standard available
Gaseous chlorides, expressed as HCl	**Aluminium:** BAT 84	Continuous or once per year[a]	EN 1911
	Zinc, Cadmium: BAT 124 **Precious metals**: BAT 144	Once per year	
Cl_2	**Aluminium**: BAT 84 **Precious metals**: BAT 144 **Nickel, Cobalt**: BAT 172	Once per year	No EN standard available
H_2S	**Aluminium:** BAT 89	Once per year	No EN standard available
PH_3	**Aluminium:** BAT 89	Once per year	No EN standard available
Sum of AsH_3 and SbH_3	**Zinc, Cadmium:** BAT 114	Once per year	No EN standard available

a For sources of high emissions, BAT is continuous measurement or, where continuous measurement is not applicable, more frequent periodic monitoring.

b For small sources (< 10 000 Nm^3/h) of dust emissions from the storage and handling of raw materials, monitoring could be based on the measurement of surrogate parameters (such as the pressure drop).

c The metals to be monitored depend on the composition of the raw materials used.

d Related to BAT 69(a), a mass balance can be used to calculate SO_2 emissions, based on the measurement of the sulphur content of each of the anode batches consumed.

e Where relevant in view of factors such as the halogenated organic compounds content of the raw materials used, the temperature profile, etc.

f Monitoring is relevant when the raw materials contain sulphur.

g Monitoring may not be relevant for hydrometallurgical processes.

h Where relevant in view of the organic compounds content of the raw materials used.

Note: 'other non-ferrous metals' means the production of non-ferrous metals other than those dealt with specifically in Sections 1.2 to 1.8.

1.1.6. **Mercury emissions**

BAT 11. In order to reduce mercury emissions to air (other than those that are routed to the sulphuric acid plant) from a pyrometallurgical process, BAT is to use one or both of the techniques given below.

	Technique
a	Use raw materials with a low mercury content, including by cooperating with

a Descriptions of the techniques are given in Section 1.10.

	providers in order to remove mercury from secondary materials.
b	Use adsorbents (e.g. activated carbon, selenium) in combination with dust filtration[a]

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 1.

TABLE 1

BAT-associated emission levels for mercury emissions to air (other than those that are routed to the sulphuric acid plant) from a pyrometallurgical process using raw materials containing mercury

Parameter	**BAT-AEL (mg/Nm^3)**[ab]
Mercury and its compounds, expressed as Hg	0,01-0,05

a As a daily average or as an average over the sampling period.

b The lower end of the range is associated with the use of adsorbents (e.g. activated carbon, selenium) in combination with dust filtration, except for processes using Waelz kilns.

The associated monitoring is in BAT 10.

1.1.7. **Sulphur dioxide emissions**

BAT 12. In order to reduce emissions of SO_2 from off-gases with a high SO_2 content and to avoid the generation of waste from the flue-gas cleaning system, BAT is to recover sulphur by producing sulphuric acid or liquid SO_2.

Applicability

Only applicable to plants producing copper, lead, primary zinc, silver, nickel and/or molybdenum.

1.1.8. **NO_X emissions**

BAT 13. In order to prevent NO_X emissions to air from a pyrometallurgical process, BAT is to use one of the techniques given below.

	Technique[a]
a	Low-NO_X burners
b	Oxy-fuel burners
c	Flue-gas recirculation (back through the burner to reduce the temperature of the flame) in the case of oxy-fuel burners

a Descriptions of the techniques are given in Section 1.10.

The associated monitoring is in BAT 10.

1.1.9. **Emissions to water, including their monitoring**

BAT 14. In order to prevent or reduce the generation of waste water, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Measure the amount of fresh water used and the amount of waste water discharged	Generally applicable
b	Reuse waste water from cleaning operations (including anode and cathode rinse water) and spills in the same process	Generally applicable
c	Reuse weak acid streams generated in a wet ESP and wet scrubbers	Applicability may be restricted depending on the metal and solid content of the waste water
d	Reuse waste water from slag granulation	Applicability may be restricted depending on the metal and solid content of the waste water
e	Reuse surface run-off water	Generally applicable
f	Use a closed circuit cooling system	Applicability may be restricted when a low temperature is required for process reasons
g	Reuse treated water from the waste water treatment plant	Applicability may be restricted by the salt content

BAT 15. In order to prevent the contamination of water and to reduce emissions to water, BAT is to segregate uncontaminated waste water streams from waste water streams requiring treatment.

Applicability

The segregation of uncontaminated rainwater may not be applicable in the case of existing waste water collection systems.

BAT 16. BAT is to use ISO 5667 for water sampling and to monitor the emissions to water at the point where the emission leaves the installation at least once per month[(3)] 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.

Parameter	Applicable for the production of[a]	Standard(s)
Mercury (Hg)	Copper, Lead, Tin, Zinc, Cadmium, Precious metals, Ferro-alloys, Nickel, Cobalt, and other non-ferrous metals	EN ISO 17852, EN ISO 12846

a *Note:*'other non-ferrous metals' means the production of non-ferrous metals other than those dealt with specifically in Sections 1.2 to 1.8.

b The metals monitored depend on the composition of the raw material used.

Iron (Fe)	Copper, Lead, Tin, Zinc, Cadmium, Precious metals, Ferro-alloys, Nickel, Cobalt, and other non-ferrous metals	EN ISO 11885 EN ISO 15586 EN ISO 17294-2
Arsenic (As)	Copper, Lead, Tin, Zinc, Cadmium, Precious metals, Ferro-alloys, Nickel, and Cobalt	
Cadmium (Cd)		
Copper (Cu)		
Nickel (Ni)		
Lead (Pb)		
Zinc (Zn)		
Silver (Ag)	Precious metals	
Aluminium (Al)	Aluminium	
Cobalt (Co)	Nickel, and Cobalt	
Chromium total (Cr)	Ferro-alloys	
Chromium(VI) (Cr(VI))	Ferro-alloys	EN ISO 10304-3 EN ISO 23913
Antimony (Sb)	Copper, Lead, and Tin	EN ISO 11885 EN ISO 15586 EN ISO 17294-2
Tin (Sn)	Copper, Lead, and Tin	
Other metals, if relevant[b]	Aluminium, Ferro-alloys, and other non-ferrous metals	
Sulphate (SO_4^{2-})	Copper, Lead, Tin, Zinc, Cadmium, Precious metals, Nickel, Cobalt, and other non-ferrous metals	EN ISO 10304-1
Fluoride (F)	Primary aluminium	
Total suspended solids (TSS)	Aluminium	EN 872

a *Note:*'other non-ferrous metals' means the production of non-ferrous metals other than those dealt with specifically in Sections 1.2 to 1.8.

b The metals monitored depend on the composition of the raw material used.

BAT 17. In order to reduce emissions to water, BAT is to treat the leakages from the storage of liquids and the waste water from non-ferrous metals production, including from the washing stage in the Waelz kiln process, and to remove metals and sulphates by using a combination of the techniques given below.

	Technique[a]	Applicability
a	Chemical precipitation	Generally applicable
b	Sedimentation	Generally applicable
c	Filtration	Generally applicable

a Descriptions of the techniques are given in Section 1.10.

d	Flotation	Generally applicable
e	Ultrafiltration	Only applicable to specific streams in non-ferrous metals production
f	Activated carbon filtration	Generally applicable
g	Reverse osmosis	Only applicable to specific streams in non-ferrous metals production

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels

The BAT-associated emission levels (BAT-AELs) for direct emissions to a receiving water body from the production of copper, lead, tin, zinc, cadmium, precious metals, nickel, cobalt and ferro-alloys are given in Table 2.

These BAT-AELs apply at the point where the emission leaves the installation.

TABLE 2

BAT-associated emission levels for direct emissions to a receiving water body from the production of copper, lead, tin, zinc (including the waste water from the washing stage in the Waelz kiln process), cadmium, precious metals, nickel, cobalt and ferro-alloys

BAT-AEL (mg/l) (daily average)						
Parameter	**Production of**					
	Copper	**Lead and/or Tin**	**Zinc and/or Cadmium**	**Precious metals**	**Nickel and/or Cobalt**	**Ferro-alloys**
Silver (Ag)	NR			≤ 0,6	NR	
Arsenic (As)	≤ 0,1[a]	≤ 0,1	≤ 0,1	≤ 0,1	≤ 0,3	≤ 0,1
Cadmium (Cd)	0,02–0,1	≤ 0,1	≤ 0,1	≤ 0,05	≤ 0,1	≤ 0,05
Cobalt (Co)	NR	≤ 0,1	NR		0,1-0,5	NR
Chromium total (Cr)	NR					≤ 0,2
Chromium (VI) (Cr(VI))	NR					≤ 0,05
Copper (Cu)	0,05-0,5	≤ 0,2	≤ 0,1	≤ 0,3	≤ 0,5	≤ 0,5
Mercury (Hg)	0,005–0,02	≤ 0,05	≤ 0,05	≤ 0,05	≤ 0,05	≤ 0,05

a In the case of a high arsenic content in the total input of the plant, the BAT-AEL may be up to 0,2 mg/l.

NR: Not relevant

Nickel (Ni)	≤ 0,5	≤ 0,5	≤ 0,1	≤ 0,5	≤ 2	≤ 2
Lead (Pb)	≤ 0,5	≤ 0,5	≤ 0,2	≤ 0,5	≤ 0,5	≤ 0,2
Zinc (Zn)	≤ 1	≤ 1	≤ 1	≤ 0,4	≤ 1	≤ 1

a In the case of a high arsenic content in the total input of the plant, the BAT-AEL may be up to 0,2 mg/l.

NR: Not relevant

The associated monitoring is in BAT 16.

1.1.10. **Noise**

BAT 18. In order to reduce noise emissions, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use embankments to screen the source of noise
b	Enclose noisy plants or components in sound-absorbing structures
c	Use anti-vibration supports and interconnections for equipment
d	Orientation of noise-emitting machinery
e	Change the frequency of the sound

1.1.11. **Odour**

BAT 19. In order to reduce odour emissions, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Appropriate storage and handling of odorous materials	Generally applicable
b	Minimise the use of odorous materials	Generally applicable
c	Careful design, operation and maintenance of any equipment that could generate odour emissions	Generally applicable
d	Afterburner or filtration techniques, including biofilters	Applicable only in limited cases (e.g. in the impregnation stage during speciality production in the carbon and graphite sector)

1.2. BAT CONCLUSIONS FOR COPPER PRODUCTION

1.2.1. Secondary materials

BAT 20. In order to increase the secondary materials' recovery yield from scrap, BAT is to separate non-metallic constituents and metals other than copper by using one or a combination of the techniques given below.

	Technique
a	Manual separation of large visible constituents
b	Magnetic separation of ferrous metals
c	Optical or eddy current separation of aluminium
d	Relative density separation of different metallic and non-metallic constituents (using a fluid with a different density or air)

1.2.2. Energy

BAT 21. In order to use energy efficiently in primary copper production, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Optimise the use of the energy contained in the concentrate using a flash smelting furnace	Only applicable for new plants and for major upgrades of existing plants
b	Use the hot process gases from the melting stages to heat up the furnace charge	Only applicable to shaft furnaces
c	Cover the concentrates during transport and storage	Generally applicable
d	Use the excess heat produced during the primary smelting or converting stages to melt secondary materials containing copper	Generally applicable
e	Use the heat in the gases from anode furnaces in a cascade for other processes such as drying	Generally applicable

BAT 22. In order to use energy efficiently in secondary copper production, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability

a	Reduce the water content of the feed material	Applicability is limited when the moisture content of the materials is used as a technique to reduce diffuse emissions
b	Produce steam by recovering excess heat from the smelting furnace to heat up the electrolyte in refineries and/or to produce electricity in a co-generation installation	Applicable if an economically viable demand of steam exists
c	Melt scraps using the excess heat that is produced during the smelting or converting process	Generally applicable
d	Holding furnace between processing stages	Only applicable for batch-wise operated smelters where a buffer capacity of molten material is required
e	Preheat the furnace charge using the hot process gases from the melting stages	Only applicable to shaft furnaces

BAT 23. In order to use energy efficiently in electrorefining and electrowinning operations, BAT is to use a combination of the techniques given below.

	Technique	**Applicability**
a	Apply insulation and covers to electrolysis tanks	Generally applicable
b	Addition of surfactants to the electrowinning cells	Generally applicable
c	Improved cell design for lower energy consumption by optimisation of the following parameters: space between anode and cathode, anode geometry, current density, electrolyte composition and temperature	Only applicable for new plants and for major upgrades of existing plants
d	Use of stainless steel cathode blanks	Only applicable for new plants and for major upgrades of existing plants
e	Automatic cathode/anode changes to achieve an accurate placement of the electrodes into the cell	Only applicable for new plants and for major upgrades of existing plants

f	Short circuit detection and quality control to ensure that electrodes are straight and flat and that the anode is exact in weight	Generally applicable

1.2.3. **Air emissions**

BAT 24. In order to reduce secondary emissions to air from furnaces and auxiliary devices in primary copper production and to optimise the performance of the abatement system, BAT is to collect, mix and treat secondary emissions in a centralised off-gas cleaning system.

Description

Secondary emissions from various sources are collected, mixed, and treated in a single centralised off-gas cleaning system, designed to effectively treat the pollutants present in each of the flows. Care is taken not to mix streams which are not chemically compatible and to avoid undesirable chemical reactions among the different collected flows.

Applicability

The applicability may be limited for existing plants by their design and layout.

1.2.3.1. *Diffuse emissions*

BAT 25. In order to prevent or reduce diffuse emissions from pretreatment (such as blending, drying, mixing, homogenisation, screening and pelletisation) of primary and secondary materials, BAT is to use one or a combination of the techniques given below.

	Technique	**Applicability**
a	Use enclosed conveyers or pneumatic transfer systems for dusty materials	Generally applicable
b	Carry out activities with dusty materials such as mixing in an enclosed building	For existing plants, application may be difficult due to the space requirements
c	Use dust suppression systems such as water cannons or water sprinklers	Not applicable for mixing operations carried out indoors. Not applicable for processes that require dry materials. The application is also limited in regions with water shortages or with very low temperatures
d	Use enclosed equipment for operations with dusty material (such as drying, mixing, milling, air separation and pelletisation) with an air extraction system	Generally applicable

	connected to an abatement system	
e	Use an extraction system for dusty and gaseous emissions, such as a hood in combination with a dust and gas abatement system	Generally applicable

BAT 26. In order to prevent or reduce diffuse emissions from charging, smelting and tapping operations in primary and secondary copper smelters and from holding and melting furnaces, BAT is to use a combination of the techniques given below.

	Technique	**Applicability**
a	Briquetting and pelletisation of raw materials	Applicable only when the process and the furnace can use pelletised raw materials
b	Enclosed charging system such as single jet burner, door sealing[a], closed conveyers or feeders equipped with an air extraction system in combination with a dust and gas abatement system	The jet burner is applicable only for flash furnaces
c	Operate the furnace and gas route under negative pressure and at a sufficient gas extraction rate to prevent pressurisation	Generally applicable
d	Capture hood/enclosures at charging and tapping points in combination with an off-gas abatement system (e.g. housing/tunnel for ladle operation during tapping, and which is closed with a movable door/barrier equipped with a ventilation and abatement system)	Generally applicable
e	Encapsulate the furnace in vented housing	Generally applicable
f	Maintain furnace sealing	Generally applicable
g	Hold the temperature in the furnace at the lowest required level	Generally applicable
h	Boosted suction systems[a]	Generally applicable

a Description of the technique is given in Section 1.10.

i	Enclosed building in combination with other techniques to collect the diffuse emissions	Generally applicable
j	Double bell charging system for shaft/blast furnaces	Generally applicable
k	Select and feed the raw materials according to the type of furnace and abatement techniques used	Generally applicable
l	Use of lids on throats of rotary anode furnace	Generally applicable

a Description of the technique is given in Section 1.10.

BAT 27. In order to reduce diffuse emissions from Peirce-Smith converter (PS) furnace in primary and secondary copper production, BAT is to use a combination of the techniques given below.

	Technique
a	Operate the furnace and gas route under negative pressure and at a sufficient gas extraction rate to prevent pressurisation
b	Oxygen enrichment
c	Primary hood over the converter opening to collect and transfer the primary emissions to an abatement system
d	Addition of materials (e.g. scrap and flux) through the hood
e	System of secondary hoods in addition to the main one to capture emissions during charging and tapping operations
f	Furnace located in enclosed building
g	Apply motor-driven secondary hoods, to move them according to the process stage, to increase the efficiency of the collection of secondary emissions
h	Boosted suction systems[a] and automatic control to prevent blowing when the converter is ‘rolled out’ or ‘rolled in’

a Description of the technique is given in Section 1.10.

BAT 28. In order to reduce diffuse emissions from a Hoboken converter furnace in primary copper production, BAT is to use a combination of the techniques given below.

	Technique
a	Operate furnace and gas route under negative pressure during charging, skimming and tapping operations
b	Oxygen enrichment
c	Mouth with closed lids during operation
d	Boosted suction systems[a]

a Description of the technique is given in Section 1.10.

BAT 29. In order to reduce diffuse emissions from the matte conversion process, BAT is to use a flash converting furnace.

Applicability

Applicable only to new plants or major upgrades of existing plants.

BAT 30. In order to reduce diffuse emissions from a top-blown rotary converter (TBRC) furnace in secondary copper production, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Operate the furnace and gas route under negative pressure and at a sufficient gas extraction rate to prevent pressurisation	Generally applicable
b	Oxygen enrichment	Generally applicable
c	Furnace located in enclosed building in combination with techniques to collect and transfer diffuse emissions from charging and tapping to an abatement system	Generally applicable
d	Primary hood over the converter opening to collect and transfer the primary emissions to an abatement system	Generally applicable
e	Hoods or crane integrated hood to collect and transfer the emissions from charging and tapping operations to an abatement system	For existing plants, a crane integrated hood is only applicable to major upgrades of the furnace hall
f	Addition of materials (e.g. scrap and flux) through the hood	Generally applicable

a Description of the technique is given in Section 1.10.

g	Boosted suction system[a]	Generally applicable

a Description of the technique is given in Section 1.10.

BAT 31. In order to reduce diffuse emissions from copper recovery with a slag concentrator, BAT is to use the techniques given below.

	Technique
a	Dust suppression techniques such as a water spray for handling, storage and crushing of slag
b	Grinding and flotation performed with water
c	Delivery of the slag to the final storage area via hydro transport in a closed pipeline
d	Maintain a water layer in the pond or use a dust suppressant such as lime milk in dry areas

BAT 32. In order to reduce diffuse emissions from copper-rich slag furnace treatment, BAT is to use a combination of the techniques given below.

	Technique
a	Dust suppression techniques such as a water spray for handling, storage and crushing of the final slag
b	Operation of the furnace under negative pressure
c	Enclosed furnace
d	Housing, enclosure and hood to collect and transfer the emissions to an abatement system
e	Covered launder

BAT 33. In order to reduce diffuse emissions from anode casting in primary and secondary copper production, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use an enclosed tundish
b	Use a closed intermediate ladle
c	Use a hood, equipped with an air extraction system, over the casting ladle and over the casting wheel

BAT 34. In order to reduce diffuse emissions from electrolysis cells, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Addition of surfactants to the electrowinning cells	Generally applicable
b	Use covers or a hood to collect and transfer the emissions to an abatement system	Only applicable for electrowinning cells or refining cells for low-purity anodes. Not applicable when the cell needs to remain uncovered to maintain the cell temperature at workable levels (approximately 65 °C)
c	Closed and fixed pipelines for transferring the electrolyte solutions	Generally applicable
d	Gas extraction from the washing chambers of the cathode stripping machine and anode scrap washing machine	Generally applicable

BAT 35. In order to reduce diffuse emissions from the casting of copper alloys, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use enclosures or hoods to collect and transfer the emissions to an abatement system
b	Use covering for the melts in holding and casting furnaces
c	Boosted suction system[a]

a Description of the technique is given in Section 1.10.

BAT 36. In order to reduce diffuse emissions from non-acid and acid pickling, BAT is to use one of the techniques given below.

	Technique	Applicability
a	Encapsulate the pickling line with a solution of isopropanol operating in a closed circuit	Only applicable for pickling of copper wire rod in continuous operations
b	Encapsulate the pickling line to collect and transfer the	Only applicable for acid pickling in continuous operations

	emissions to an abatement system	

1.2.3.2. *Channelled dust emissions*

Descriptions of the techniques mentioned in this section are given in Section 1.10.

The BAT-associated emission levels are all given in Table 3.

BAT 37. In order to reduce dust and metal emissions to air from the reception, storage, handling, transport, metering, mixing, blending, crushing, drying, cutting and screening of raw materials, and the pyrolytic treatment of copper turnings in primary and secondary copper production, BAT is to use a bag filter.

BAT 38. In order to reduce dust and metal emissions to air from concentrate drying in primary copper production, BAT is to use a bag filter.

Applicability

In the event of a high organic carbon content in the concentrates (e.g. around 10 wt-%), bag filters may not be applicable (due to blinding of the bags) and other techniques (e.g. ESP) may be used.

BAT 39. In order to reduce dust and metal emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant or power plant) from the primary copper smelter and converter, BAT is to use a bag filter and/or a wet scrubber.

BAT 40. In order to reduce dust and metal emissions to air (other than those that are routed to the sulphuric acid plant) from the secondary copper smelter and converter and from the processing of secondary copper intermediates, BAT is to use a bag filter.

BAT 41. In order to reduce dust and metal emissions to air from the secondary copper holding furnace, BAT is to use a bag filter.

BAT 42. In order to reduce dust and metal emissions to air from copper-rich slag furnace processing, BAT is to use a bag filter or a scrubber in combination with an ESP.

BAT 43. In order to reduce dust and metal emissions to air from the anode furnace in primary and secondary copper production, BAT is to use a bag filter or a scrubber in combination with an ESP.

BAT 44. In order to reduce dust and metal emissions to air from anode casting in primary and secondary copper production, BAT is to use a bag filter or, in the case of off-gases with a water content close to the dew point, a wet scrubber or a demister.

BAT 45. In order to reduce dust and metal emissions to air from a copper melting furnace, BAT is to select and feed the raw materials according to the furnace type and the abatement system used and to use a bag filter.

TABLE 3

BAT-associated emission levels for dust emissions to air from copper production

Parameter	BAT	Process	BAT-AEL (mg/Nm^3)
Dust	BAT 37	Reception, storage, handling, transport, metering, mixing, blending, crushing, drying, cutting and screening of raw materials, and the pyrolytic treatment of copper turnings in primary and secondary copper production	2-5[ad]
	BAT 38	Concentrate drying in primary copper production	3-5[bde]
	BAT 39	Primary copper smelter and converter (emissions other than those that are routed to the sulphuric acid or liquid SO_2 plant or power plant)	2-5[cd]
	BAT 40	Secondary copper smelter and converter and processing of secondary copper intermediates (emissions other than those that are routed to the sulphuric acid plant)	2-4[bd]
	BAT 41	Secondary copper holding furnace	≤ 5[a]
	BAT 42	Copper-rich slag furnace processing	2-5[af]

a	As an average over the sampling period.
b	As a daily average or as an average over the sampling period.
c	As a daily average.
d	Dust emissions are expected to be towards the lower end of the range when emissions of heavy metals are above the following levels: 1 mg/Nm^3 for lead, 1 mg/Nm^3 for copper, 0,05 mg/Nm^3 for arsenic, 0,05 mg/Nm^3 for cadmium.
e	When the concentrates used have a high organic carbon content (e.g. around 10 wt-%), emissions of up to 10 mg/Nm^3 can be expected.
f	Dust emissions are expected to be towards the lower end of the range when emissions of lead are above 1 mg/Nm^3.
g	The lower end of the range is associated with the use of a bag filter.
h	Dust emissions are expected to be towards the lower end of the range when emissions of copper are above 1 mg/Nm^3.

	BAT 43	Anode furnace (in primary and secondary copper production)	2-5[bf]
	BAT 44	Anode casting (in primary and secondary copper production)	≤ 5-15[bg]
	BAT 45	Copper melting furnace	2-5[bh]

a	As an average over the sampling period.
b	As a daily average or as an average over the sampling period.
c	As a daily average.
d	Dust emissions are expected to be towards the lower end of the range when emissions of heavy metals are above the following levels: 1 mg/Nm^3 for lead, 1 mg/Nm^3 for copper, 0,05 mg/Nm^3 for arsenic, 0,05 mg/Nm^3 for cadmium.
e	When the concentrates used have a high organic carbon content (e.g. around 10 wt-%), emissions of up to 10 mg/Nm^3 can be expected.
f	Dust emissions are expected to be towards the lower end of the range when emissions of lead are above 1 mg/Nm^3.
g	The lower end of the range is associated with the use of a bag filter.
h	Dust emissions are expected to be towards the lower end of the range when emissions of copper are above 1 mg/Nm^3.

The associated monitoring is in BAT 10.

1.2.3.3. *Organic compound emissions*

BAT 46. In order to reduce organic compound emissions to air from the pyrolytic treatment of copper turnings, and the drying, smelting and melting of secondary raw materials, BAT is to use one of the techniques given below.

	Technique[a]	**Applicability**
a	Afterburner or post-combustion chamber or regenerative thermal oxidiser	The applicability is restricted by the energy content of the off-gases that need to be treated, as off-gases with a lower energy content require a higher fuel use
b	Injection of adsorbent in combination with a bag filter	Generally applicable
c	Design of furnace and the abatement techniques according to the raw materials available	Only applicable to new furnaces or major upgrades of existing furnaces
d	Select and feed the raw materials according to the furnace and the abatement techniques used	Generally applicable

a	Descriptions of the techniques are given in Section 1.10.

e	Thermal destruction of TVOC at high temperatures in the furnace (> 1 000 °C)	Generally applicable

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 4.

TABLE 4

BAT-associated emission levels for emissions to air of TVOC from the pyrolytic treatment of copper turnings, and the drying, smelting and melting of secondary raw materials

Parameter	**BAT-AEL (mg/Nm^3)[a][b]**
TVOC	3-30

a As a daily average or as an average over the sampling period.

b The lower end of the range is associated with the use of a regenerative thermal oxidiser.

The associated monitoring is in BAT 10.

BAT 47. In order to reduce organic compound emissions to air from solvent extraction in hydrometallurgical copper production, BAT is to use both of the techniques given below and to determine the VOC emissions annually, e.g. through mass balance.

	Technique
a	Process reagent (solvent) with lower steam pressure
b	Closed equipment such as closed mixing tanks, closed settlers and closed storage tanks

BAT 48. In order to reduce PCDD/F emissions to air from the pyrolytic treatment of copper turnings, smelting, melting, fire refining and converting operations in secondary copper production, BAT is to use one or a combination of the techniques given below.

	Technique
a	Select and feed the raw materials according to the furnace and the abatement techniques used
b	Optimise combustion conditions to reduce the emissions of organic compounds
c	Use charging systems, for a semi-closed furnace, to give small additions of raw material
d	Thermal destruction of PCDD/F in the furnace at high temperatures (> 850 °C)
e	Use oxygen injection in the upper zone of the furnace

a Descriptions of the techniques are given in Section 1.10.

f	Internal burner system
g	Post-combustion chamber or afterburner or regenerative thermal oxidiser[a]
h	Avoid exhaust systems with a high dust build-up for temperatures > 250 °C
i	Rapid quenching[a]
j	Injection of adsorption agent in combination with an efficient dust collection system[a]

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 5.

TABLE 5

BAT-associated emission levels for PCDD/F emissions to air from the pyrolytic treatment of copper turnings, smelting, melting, fire refining and converting operations in secondary copper production

Parameter	BAT-AEL (ng I-TEQ/Nm^3)[a]
PCDD/F	≤ 0,1

a As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.2.3.4. *Sulphur dioxide emissions*

Descriptions of the techniques mentioned in this section are given in Section 1.10.

BAT 49. In order to reduce SO_2 emissions (other than those that are routed to the sulphuric acid or liquid SO_2 plant or power plant) from primary and secondary copper production, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Dry or semi-dry scrubber	Generally applicable
b	Wet scrubber	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)
c	Polyether-based absorption/ desorption system	Not applicable in the case of secondary copper production.

		Not applicable in the absence of a sulphuric acid or liquid SO_2 plant

BAT-associated emission levels: See Table 6.

TABLE 6

BAT-associated emission levels for SO_2 emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant or power plant) from primary and secondary copper production

Parameter	Process	BAT-AEL (mg/Nm^3)[a]
SO_2	Primary copper production	50-500[b]
	Secondary copper production	50-300

a As a daily average or as an average over the sampling period.

b In the case of using a wet scrubber or a concentrate with a low sulphur content, the BAT-AEL can be up to 350 mg/Nm^3.

The associated monitoring is in BAT 10.

1.2.3.5. *Acid emissions*

BAT 50. In order to reduce acid gas emissions to air from exhaust gases from the electrowinning cells, the electrorefining cells, the washing chamber of the cathode stripping machine and the anode scrap washing machine, BAT is to use a wet scrubber or a demister.

1.2.4. **Soil and groundwater**

BAT 51. In order to prevent soil and groundwater contamination from copper recovery in the slag concentrator, BAT is to use a drainage system in cooling areas and a correct design of the final slag storage area to collect overflow water and avoid fluid leakage.

BAT 52. In order to prevent soil and groundwater contamination from the electrolysis in primary and secondary copper production, BAT is to use a combination of the techniques given below.

	Technique
a	Use of a sealed drainage system
b	Use of impermeable and acid-resistant floors
c	Use of double-walled tanks or placement in resistant bunds with impermeable floors

1.2.5. **Waste water generation**

BAT 53. In order to prevent the generation of waste water from primary and secondary copper production, BAT is to use one or a combination of the techniques given below.

	Technique

a	Use the steam condensate for heating the electrolysis cells, to wash the copper cathodes or send it back to steam boiler
b	Reuse the water collected from the cooling area, flotation process and hydro transportation of final slag in the slag concentration process
c	Recycle the pickling solutions and the rinse water
d	Treat the residues (crude) from the solvent extraction step in hydrometallurgical copper production to recover the organic solution content
e	Centrifuge the slurry from cleaning and settlers from the solvent extraction step in hydrometallurgical copper production
f	Reuse the electrolysis bleed after the metal removal stage in the electrowinning and/or the leaching process

1.2.6. **Waste**

BAT 54. In order to reduce the quantities of waste sent for disposal from primary and secondary copper production, BAT is to organise operations so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique	Applicability
a	Recover metals from the dust and slime coming from the dust abatement system	Generally applicable
b	Reuse or sell the calcium compounds (e.g. gypsum) generated by the abatement of SO_2	Applicability may be restricted depending on the metal content and on the availability of a market
c	Regenerate or recycle the spent catalysts	Generally applicable
d	Recover metal from the waste water treatment slime	Applicability may be restricted depending on the metal content and on the availability of a market/ process
e	Use weak acid in the leaching process or for gypsum production	Generally applicable

f	Recover the copper content from the rich slag in the slag furnace or slag flotation plant	
g	Use the final slag from furnaces as an abrasive or (road) construction material or for another viable application	Applicability may be restricted depending on the metal content and on the availability of a market
h	Use the furnace lining for recovery of metals or reuse as refractory material	
i	Use the slag from the slag flotation as an abrasive or construction material or for another viable application	
j	Use the skimming from the melting furnaces to recover the metal content	Generally applicable
k	Use the spent electrolyte bleed to recover copper and nickel. Reuse the remaining acid to make up the new electrolyte or to produce gypsum	
l	Use the spent anode as a cooling material in pyrometallurgical copper refining or remelting	
m	Use anode slime to recover precious metals	
n	Use the gypsum from the waste water treatment plant in the pyrometallurgical process or for sale	Applicability may be restricted depending on the quality of the generated gypsum
o	Recover metals from sludge	Generally applicable
p	Reuse the depleted electrolyte from the hydrometallurgical copper process as a leaching agent	Applicability may be restricted depending on the metal content and on the availability of a market/ process
q	Recycle copper scales from rolling in a copper smelter	Generally applicable
r	Recover metals from the spent acid pickling solution and reuse the cleaned acid solution	

1.3. BAT CONCLUSIONS FOR ALUMINIUM PRODUCTION INCLUDING ALUMINA AND ANODE PRODUCTION

1.3.1. **Alumina production**

1.3.1.1. *Energy*

BAT 55. In order to use energy efficiently during the production of alumina from bauxite, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a	Plate heat exchangers	Plate heat exchangers allow a higher heat recovery from the liquor flowing to the precipitation area in comparison with other techniques such as flash cooling plants	Applicable if the energy from the cooling fluid can be reused in the process and if the condensate balance and the liquor conditions allow it
b	Circulating fluidised bed calciners	Circulating fluidised bed calciners have a much higher energy efficiency than rotary kilns, since the heat recovery from the alumina and the flue-gas is greater	Only applicable to smelter-grade aluminas. Not applicable to speciality/non-smelter-grade aluminas, as these require a higher level of calcination that can currently only be achieved with a rotary kiln
c	Single stream digestion design	The slurry is heated up in one circuit without using live steam and therefore without dilution of the slurry (in contrast to the double-stream digestion design)	Only applicable to new plants
d	Selection of the bauxite	Bauxite with a higher moisture content carries more water into the process, which increases the energy need for evaporation. In addition, bauxites with a high monohydrate content (boehmite and/or	Applicable within the constraints related to the specific design of the plant, since some plants are specifically designed for a certain quality of bauxite, which limits the use of alternative bauxite sources

		diaspore) require a higher pressure and temperature in the digestion process, leading to higher energy consumption	

1.3.1.2. *Air emissions*

BAT 56. In order to reduce dust and metal emissions from alumina calcination, BAT is to use a bag filter or an ESP.

1.3.1.3. *Waste*

BAT 57. In order to reduce the quantities of waste sent for disposal and to improve the disposal of bauxite residues from alumina production, BAT is to use one or both of the techniques given below.

	Technique
a	Reduce the volume of bauxite residues by compacting in order to minimise the moisture content, e.g. using vacuum or high-pressure filters to form a semi-dry cake
b	Reduce/minimise the alkalinity remaining in the bauxite residues in order to allow disposal of the residues in a landfill

1.3.2. **Anode production**

1.3.2.1. *Air emissions*

1.3.2.1.1. *Dust, PAH and fluoride emissions from the paste plant*

BAT 58. In order to reduce dust emissions to air from a paste plant (removing coke dust from operations such as coke storage and grinding), BAT is to use a bag filter.

BAT-associated emission levels: See Table 7.

BAT 59. In order to reduce dust and PAH emissions to air from a paste plant (hot pitch storage, paste mixing, cooling and forming), BAT is to use one or a combination of the techniques given below.

	Technique[a]
a	Dry scrubber using coke as the adsorbent agent, with or without precooling, followed by a bag filter
b	Regenerative thermal oxidiser
c	Catalytic thermal oxidiser

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 7.

TABLE 7

BAT-associated emission levels for dust and BaP (as an indicator of PAH) emissions to air from a paste plant

Parameter	Process	BAT-AEL (mg/Nm^3)
Dust	— Hot pitch storage, paste mixing, cooling and forming — Removing coke dust from operations such as coke storage and grinding	2-5[a]
BaP	Hot pitch storage, paste mixing, cooling and forming	0,001-0,01[b]

a As a daily average or as an average over the sampling period.

b As an average over the sampling period.

The associated monitoring is in BAT 10.

1.3.2.1.2. *Dust, sulphur dioxide, PAH and fluoride emissions from the baking plant*

BAT 60. In order to reduce dust, sulphur dioxide, PAH and fluoride emissions to air from a baking plant in an anode production plant integrated with a primary aluminium smelter, BAT is to use one or a combination of the techniques given below.

	Technique[a]	Applicability
a	Use of raw materials and fuels containing a low amount of sulphur	Generally applicable for reducing SO_2 emissions
b	Dry scrubber using alumina as the adsorbent agent followed by a bag filter	Generally applicable for reducing dust, PAH and fluoride emissions
c	Wet scrubber	Applicability for reducing dust, SO_2, PAH and fluoride emissions may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and

a Descriptions of the techniques are given in Section 1.10.

		the need for waste water treatment)
d	Regenerative thermal oxidiser in combination with a dust abatement system	Generally applicable for reducing dust and PAH emissions.

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 8.

TABLE 8

BAT-associated emission levels for dust, BaP (as an indicator of PAH) and fluoride emissions to air from a baking plant in an anode production plant integrated with a primary aluminium smelter

Parameter	BAT-AEL (mg/Nm^3)
Dust	2-5[a]
BaP	0,001-0,01[b]
HF	0,3-0,5[a]
Total fluorides	≤ 0,8[b]

a As a daily average or as an average over the sampling period.

b As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 61. In order to reduce dust, PAH and fluoride emissions to air from a baking plant in a stand-alone anode production plant, BAT is to use a pre-filtration unit and a regenerative thermal oxidiser followed by a dry scrubber (e.g. lime bed).

BAT-associated emission levels: See Table 9.

TABLE 9

BAT-associated emission levels for dust, BaP (as an indicator of PAH) and fluoride emissions to air from a baking plant in a stand-alone anode production plant

Parameter	BAT-AEL (mg/Nm^3)
Dust	2-5[a]
BaP	0,001-0,01[b]
HF	≤ 3[a]

a As a daily average.

b As an average over the sampling period.

The associated monitoring is in BAT 10.

1.3.2.2. *Waste water generation*

BAT 62. In order to prevent the generation of waste water from anode baking, BAT is to use a closed water cycle.

Applicability

Generally applicable to new plants and major upgrades. The applicability may be limited due to water quality and/or product quality requirements.

1.3.2.3. *Waste*

BAT 63. In order to reduce the quantities of waste sent for disposal, BAT is to recycle carbon dust from the coke filter as a scrubbing medium.

Applicability

There may be restrictions on applicability depending on the ash content of the carbon dust.

1.3.3. **Primary aluminium production**

1.3.3.1. *Air emissions*

BAT 64. In order to prevent or collect diffuse emissions from electrolytic cells in primary aluminium production using the Søderberg technology, BAT is to use a combination of the techniques given below.

	Technique
a	Use of paste with a pitch content between 25 % and 28 % (dry paste)
b	Upgrade the manifold design to allow closed point feeding operations and improved off-gas collection efficiency
c	Alumina point feeding
d	Increased anode height combined with the treatment in BAT 67
e	Anode top hooding when high current density anodes are used, connected to the treatment in BAT 67

Description

BAT 64(c): Point feeding of alumina avoids the regular crust-breaking (such as during manual side feed or bar broken feed), and thus reduces the associated fluoride and dust emissions.

BAT 64(d): An increased anode height helps to achieve lower temperatures in the anode top, resulting in lower emissions to air.

BAT-associated emission levels: See Table 12.

BAT 65. In order to prevent or collect diffuse emissions from electrolytic cells in primary aluminium production using prebaked anodes, BAT is to use a combination of the techniques given below.

	Technique
a	Automatic multiple point feeding of alumina
b	Complete hood coverage of the cell and adequate off-gas extraction rates (to lead the off-gas to the treatment in BAT 67) taking

	into account fluoride generation from bath and carbon anode consumption
c	Boosted suction system connected to the abatement techniques listed in BAT 67
d	Minimisation of the time for changing anodes and other activities that require cell hoods to be removed
e	Efficient process control system avoiding process deviations that might otherwise lead to increased cell evolution and emissions
f	Use of a programmed system for cell operations and maintenance
g	Use of established efficient cleaning methods in the rodding plant to recover fluorides and carbon
h	Storage of removed anodes in a compartment near the cell, connected to the treatment in BAT 67, or storage of the butts in confined boxes

Applicability

BAT 65.c and h are not applicable to existing plants

BAT-associated emission levels: See Table 12.

1.3.3.1.1. *Channelled dust and fluoride emissions*

BAT 66. In order to reduce dust emissions from the storage, handling and transport of raw materials, BAT is to use a bag filter.

BAT-associated emission levels: See Table 10.

TABLE 10

BAT-associated emission levels for dust from the storage, handling and transport of raw materials

Parameter	**BAT-AEL (mg/Nm^3)[a]**
Dust	≤ 5-10
a As an average over the sampling period.	

The associated monitoring is in BAT 10.

BAT 67. In order to reduce dust, metal and fluoride emissions to air from electrolytic cells, BAT is to use one of the techniques given below.

	Technique[a]	**Applicability**
a Descriptions of the techniques are given in Section 1.10		

a	Dry scrubber using alumina as the adsorbent agent followed by a bag filter	Generally applicable
b	Dry scrubber using alumina as the adsorbent agent followed by a bag filter and a wet scrubber	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)

a Descriptions of the techniques are given in Section 1.10

BAT-associated emission levels: See Table 11 and Table 12.

TABLE 11

BAT-associated emission levels for dust and fluoride emissions to air from electrolytic cells

Parameter	**BAT-AEL (mg/Nm^3)**
Dust	2-5[a]
HF	≤ 1,0[a]
Total fluorides	≤ 1,5[b]

a As a daily average or as an average over the sampling period.

b As an average over the sampling period.

The associated monitoring is in BAT 10.

1.3.3.1.2. *Total emissions of dust and fluorides*

BAT-associated emission levels for the total emissions of dust and fluoride to air from the electrolysis house (collected from the electrolytic cells and roof vents): See Table 12.

TABLE 12

BAT-associated emission levels for the total emissions of dust and fluoride to air from the electrolysis house (collected from the electrolytic cells and roof vents)

Parameter	**BAT**	**BAT-AELs for existing plants (kg/t Al)[ab]**	**BAT-AELs for new plants (kg/t Al)[a]**

a As mass of pollutant emitted during a year from the electrolysis house divided by the mass of liquid aluminium produced in the same year.

b These BAT-AELs are not applicable to plants that due to their configuration cannot measure roof emissions.

Dust	Combination of BAT 64, BAT 65 and BAT 67	≤ 1,2	≤ 0,6
Total fluorides		≤ 0,6	≤ 0,35

a As mass of pollutant emitted during a year from the electrolysis house divided by the mass of liquid aluminium produced in the same year.

b These BAT-AELs are not applicable to plants that due to their configuration cannot measure roof emissions.

The associated monitoring is in BAT 10.

BAT 68. In order to prevent or reduce dust and metal emissions to air from melting and molten metal treatment and casting in primary aluminium production, BAT is to use one or both of the techniques given below.

	Technique
a	Use of liquid metal from electrolysis and uncontaminated aluminium material, i.e. solid material free of substances such as paint, plastic or oil (e.g. the top and the bottom part of the billets that are cut for quality reasons)
b	Bag filter[a]

a Description of the technique is given in Section 1.10.

BAT-associated emission levels: See Table 13.

TABLE 13

BAT-associated emission levels for dust emissions to air from melting and molten metal treatment and casting in primary aluminium production

Parameter	BAT-AEL (mg/Nm^3)[ab]
Dust	2-25

a As an average of the samples obtained over a year.

b The lower end of the range is associated with the use of a bag filter.

The associated monitoring is in BAT 10.

1.3.3.1.3. *Sulphur dioxide emissions*

BAT 69. In order to reduce emissions to air from electrolytic cells, BAT is to use one or both of the techniques given below.

	Technique	Applicability
a	Use of low-sulphur anodes	Generally applicable
b	Wet scrubber[a]	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant

a Description of the technique is given in Section 1.10.

		amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)

a Description of the technique is given in Section 1.10.

Description

BAT 69(a): Anodes containing less than 1,5 % sulphur as a yearly average can be produced by an appropriate combination of the raw materials used. A minimum sulphur content of 0,9 % as a yearly average is required for the viability of the electrolysis process.

BAT-associated emission levels: See Table 14.

TABLE 14

BAT-associated emission levels for SO_2 emissions to air from electrolytic cells

Parameter	BAT-AEL (kg/t Al)[a][b]
SO_2	≤ 2,5-15

a As mass of pollutant emitted during a year divided by the mass of liquid aluminium produced in the same year.

b The lower end of the range is associated with the use of a wet scrubber. The higher end of the range is associated with the use of low-sulphur anodes.

The associated monitoring is in BAT 10.

1.3.3.1.4. *Perfluorocarbon emissions*

BAT 70. In order to reduce perfluorocarbon emissions to air from primary aluminium production, BAT is to use all of the techniques given below.

	Technique	Applicability
a	Automatic multiple point feeding of alumina	Generally applicable
b	Computer control of the electrolysis process based on active cell databases and monitoring of cell operating parameters	Generally applicable
c	Automatic anode effect suppression	Not applicable to Søderberg cells because the anode design (one piece only) does not allow the bath flow associated with this technique

Description

BAT 70(c): The anode effect takes place when the alumina content of the electrolyte falls below 1-2 %. During anode effects, instead of decomposing alumina, the cryolite bath is decomposed into metal and fluoride ions, the latter forming gaseous perfluorocarbons, which react with the carbon anode.

1.3.3.1.5. *PAH and CO emissions*

BAT 71. In order to reduce CO and PAH emissions to air from primary aluminium production using the Søderberg technology, BAT is to combust the CO and the PAH in the cell exhaust gas.

1.3.3.2. *Waste water generation*

BAT 72. In order to prevent the generation of waste water, BAT is to reuse or recycle cooling water and treated waste water, including rainwater, within the process.

Applicability

Generally applicable to new plants and major upgrades. The applicability may be limited due to water quality and/or product quality requirements. The amount of cooling water, treated waste water and rainwater that is reused or recycled cannot be higher than the amount of water needed for the process.

1.3.3.3. *Waste*

BAT 73. In order to reduce the disposal of spent pot lining, BAT is to organise operations on site so as to facilitate its external recycling, such as in cement manufacturing in the salt slag recovery process, as a carburiser in the steel or ferro-alloy industry or as a secondary raw material (e.g. rock wool), depending on the end consumer's requirements.

1.3.4. **Secondary aluminium production**

1.3.4.1. *Secondary materials*

BAT 74. In order to increase the raw materials' yield, BAT is to separate non-metallic constituents and metals other than aluminium by using one or a combination of the techniques given below depending on the constituents of the treated materials.

	Technique
a	Magnetic separation of ferrous metals
b	Eddy current separation (using moving electromagnetic fields) of aluminium from the other constituents
c	Relative density separation (using a fluid with a different density) of different metals and non-metallic constituents

1.3.4.2. *Energy*

BAT 75. In order to use energy efficiently, BAT is to use one or a combination of the techniques given below.

	Technique	**Applicability**

a	Preheating of the furnace charge with the exhaust gas	Only applicable for non-rotating furnaces
b	Recirculation of the gases with unburnt hydrocarbons back into the burner system	Only applicable for reverberatory furnaces and dryers
c	Supply the liquid metal for direct moulding	Applicability is limited by the time needed for the transportation (maximum 4-5 hours)

1.3.4.3. *Air emissions*

BAT 76. In order to prevent or reduce emissions to air, BAT is to remove oil and organic compounds from the swarf before the smelting stage using centrifugation and/or drying[(4)].

Applicability

Centrifugation is only applicable to highly oil-contaminated swarf, when it is applied before the drying. The removal of oil and organic compounds may not be needed if the furnace and the abatement system are designed to handle the organic material.

1.3.4.3.1. *Diffuse emissions*

BAT 77. In order to prevent or reduce diffuse emissions from the pretreatment of scraps, BAT is to use one or both of the techniques given below.

	Technique
a	Closed or pneumatic conveyor, with an air extraction system
b	Enclosures or hoods for the charging and for the discharge points, with an air extraction system

BAT 78. In order to prevent or reduce diffuse emissions from the charging and discharging/tapping of melting furnaces, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Placing a hood on top of the furnace door and at the taphole with off-gas extraction connected to a filtration system	Generally applicable
b	Fume collection enclosure that covers both the charging and tapping zones	Only applicable for stationary drum furnaces
c	Sealed furnace door[a]	Generally applicable

a Description of the technique is given in Section 1.10.

d	Sealed charging carriage	Only applicable for non-rotating furnaces
e	Boosted suction system that can be modified according to the process needed[a]	Generally applicable

a Description of the technique is given in Section 1.10.

Description

BAT 78(a) and (b): Consist of applying a covering with extraction to collect and handle the off-gases from the process.

BAT 78(d): The skip seals against the open furnace door during the discharge of scrap and maintains furnace sealing during this stage.

BAT 79. In order to reduce emissions from skimmings/dross treatment, BAT is to use one or a combination of the techniques given below.

	Technique
a	Cooling of skimmings/dross, as soon as they are skimmed from the furnace, in sealed containers under inert gas
b	Prevention of wetting of the skimmings/dross
c	Compaction of skimmings/dross with an air extraction and dust abatement system

1.3.4.3.2. *Channelled dust emissions*

BAT 80. In order to reduce dust and metal emissions from the swarf drying and the removal of oil and organic compounds from the swarf, from the crushing, milling and dry separation of non-metallic constituents and metals other than aluminium, and from the storage, handling and transport in secondary aluminium production, BAT is to use a bag filter.

BAT-associated emission levels: See Table 15.

TABLE 15

BAT-associated emission levels for dust emissions to air from the swarf drying and the removal of oil and organic compounds from the swarf, from the crushing, milling and dry separation of non-metallic constituents and metals other than aluminium, and from the storage, handling and transport in secondary aluminium production

Parameter	**BAT-AEL (mg/Nm^3)[a]**
Dust	≤ 5

a As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 81. In order to reduce dust and metal emissions to air from furnace processes such as charging, melting, tapping and molten metal treatment in secondary aluminium production, BAT is to use a bag filter.

BAT-associated emission levels: See Table 16.

TABLE 16

BAT-associated emission levels for dust emissions to air from furnace processes such as charging, melting, tapping and molten metal treatment in secondary aluminium production

Parameter	BAT-AEL (mg/Nm^3)[a]
Dust	2-5

a As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 82. In order to reduce dust and metal emissions to air from remelting in secondary aluminium production, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use of uncontaminated aluminium material i.e. solid material free of substances such as paint, plastic or oil (e.g. billets)
b	Optimise combustion conditions to reduce the emissions of dust
c	Bag filter

BAT-associated emission levels: See Table 17.

TABLE 17

BAT-associated emission levels for dust from remelting in secondary aluminium production

Parameter	BAT-AEL (mg/Nm^3)[ab]
Dust	2-5

a As an average over the sampling period.

b For furnaces designed to use and using only uncontaminated raw material, for which dust emissions are below 1 kg/h, the upper end of the range is 25 mg/Nm^3 as an average of the samples obtained over a year.

The associated monitoring is in BAT 10.

1.3.4.3.3. *Organic compound emissions*

BAT 83. In order to reduce emissions to air of organic compounds and PCDD/F from the thermal treatment of contaminated secondary raw materials (e.g. swarf) and from the melting furnace, BAT is to use a bag filter in combination with at least one of the techniques given below.

	Technique[a]
a	Select and feed the raw materials according to the furnace and the abatement techniques used
b	Internal burner system for melting furnaces
c	Afterburner
d	Rapid quenching
e	Activated carbon injection

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 18.

TABLE 18

BAT-associated emission levels for emissions to air of TVOC and PCDD/F from the thermal treatment of contaminated secondary raw materials (e.g. swarf) and from the melting furnace

Parameter	**Unit**	**BAT-AEL**
TVOC	mg/Nm^3	≤ 10-30[a]
PCDD/F	ng $I\text{-}TEQ/Nm^3$	≤ 0,1[b]

a As a daily average or as an average over the sampling period.

b As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.3.4.3.4.*Acid emissions*

BAT 84. In order to reduce emissions to air of HCl, Cl_2 and HF from the thermal treatment of contaminated secondary raw materials (e.g. swarf), the melting furnace, and remelting and molten metal treatment, BAT is to use one or a combination of the techniques given below.

Technique	
a	Select and feed the raw materials according to the furnace and the abatement techniques used[a]
b	$Ca(OH)_2$ or sodium bicarbonate injection in combination with a bag filter[a]
c	Control of the refining process, adapting the quantity of refining gas used to remove the contaminants present into the molten metals
d	Use of dilute chlorine with inert gas in the refining process

a Description of the techniques are given in Section 1.10.

Description

BAT 84(d): Using chlorine diluted with inert gas instead of only pure chlorine, to reduce the emission of chlorine. Refining can also be performed using only the inert gas.

BAT-associated emission levels: See Table 19.

TABLE 19

BAT-associated emission levels for HCl, Cl_2 and HF emissions to air from the thermal treatment of contaminated secondary raw materials (e.g. swarf), the melting furnace, and remelting and molten metal treatment

Parameter	BAT-AEL (mg/Nm^3)
HCl	≤ 5-10[a]
Cl_2	≤ 1[bc]
HF	≤ 1[d]

a As a daily average or as an average over the sampling period. For refining carried out with chemicals containing chlorine, the BAT-AEL refers to the average concentration during chlorination.

b As an average over the sampling period. For refining carried out with chemicals containing chlorine, the BAT-AEL refers to the average concentration during chlorination.

c Only applicable to emissions from refining processes carried out with chemicals containing chlorine.

d As an average over the sampling period.

The associated monitoring is in BAT 10.

1.3.4.4. *Waste*

BAT 85. In order to reduce the quantities of waste sent for disposal from secondary aluminium production, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique
a	Reuse collected dust in the process in the case of a melting furnace using salt cover or in the salt slag recovery process
b	Full recycling of the salt slag
c	Apply skimmings/dross treatment to recover aluminium in the case of furnaces that do not use salt cover

BAT 86. In order to reduce the quantities of salt slag produced from secondary aluminium production, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Increase the quality of raw material used through the separation of the non-metallic	Generally applicable

	constituents and metals other than aluminium for scraps where aluminium is mixed with other constituents	
b	Remove oil and organic constituents from contaminated swarf before melting	Generally applicable
c	Metal pumping or stirring	Not applicable for rotary furnaces
d	Tilting rotary furnace	There may be restrictions on the use of this furnace due to the size of the feed materials

1.3.5. **Salt slag recycling process**

1.3.5.1. *Diffuse emissions*

BAT 87. In order to prevent or reduce diffuse emissions from the salt slag recycling process, BAT is to use one or both of the techniques given below.

	Technique
a	Enclose equipment with gas extraction connected to a filtration system
b	Hood with gas extraction connected to a filtration system

1.3.5.2. *Channelled dust emissions*

BAT 88. In order to reduce dust and metal emissions to air from crushing and dry milling associated with the salt slag recovery process, BAT is to use a bag filter.

BAT-associated emission levels: See Table 20.

TABLE 20

BAT-associated emission levels for dust emissions to air from crushing and dry milling associated with the salt slag recovery process

Parameter	**BAT-AEL (mg/Nm^3)**[a]
Dust	2-5

a As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

1.3.5.3. *Gaseous compounds*

BAT 89. In order to reduce gaseous emissions to air from wet milling and leaching from the salt slag recovery process, BAT is to use one or a combination of the techniques given below.

	Technique[a]
a	Activated carbon injection
b	Afterburner
c	Wet scrubber with H_2SO_4 solution

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 21.

TABLE 21

BAT-associated emission levels for gaseous emissions to air from wet milling and leaching from the salt slag recovery process

Parameter	**BAT-AEL (mg/Nm^3)**[a]
NH_3	≤ 10
PH_3	≤ 0,5
H_2S	≤ 2

a As an average over the sampling period.

The associated monitoring is in BAT 10.

1.4. BAT CONCLUSIONS FOR LEAD AND/OR TIN PRODUCTION

1.4.1. **Air emissions**

1.4.1.1. *Diffuse emissions*

BAT 90. In order to prevent or reduce diffuse emissions from preparation (such as metering, mixing, blending, crushing, cutting, screening) of primary and secondary materials (excluding batteries), BAT is to use one or a combination of the techniques given below.

	Technique	**Applicability**
a	Enclosed conveyer or pneumatic transfer system for dusty material	Generally applicable
b	Enclosed equipment. When dusty materials are used the emissions are collected and sent to an abatement system	Only applicable for feed blends prepared with a dosing bin or loss-in-weight system
c	Mixing of raw materials carried out in an enclosed building	Only applicable for dusty materials. For existing plants, application may be difficult due to the space required
d	Dust suppression systems such as water sprays	Only applicable for mixing carried out outdoors

e	Pelletisation of raw materials	Applicable only when the process and the furnace can use pelletised raw materials

BAT 91. In order to prevent or reduce diffuse emissions from material pretreatment (such as drying, dismantling, sintering, briquetting, pelletising and battery crushing, screening and classifying) in primary lead and secondary lead and/or tin production, BAT is to use one or both of the techniques given below.

	Technique
a	Enclosed conveyer or pneumatic transfer system for dusty material
b	Enclosed equipment. When dusty materials are used the emissions are collected and sent to an abatement system

BAT 92. In order to prevent or reduce diffuse emissions from charging, smelting and tapping operations in lead and/or tin production, and from pre-decoppering operations in primary lead production, BAT is to use an appropriate combination of the techniques given below.

	Technique	Applicability
a	Encapsulated charging system with an air extraction system	Generally applicable
b	Sealed or enclosed furnaces with door sealing[a] for processes with a discontinuous feed and output	Generally applicable
c	Operate furnace and gas routes under negative pressure and at a sufficient gas extraction rate to prevent pressurisation	Generally applicable
d	Capture hood/enclosures at charging and tapping points	Generally applicable
e	Enclosed building	Generally applicable
f	Complete hood coverage with an air extraction system	In existing plants or major upgrades of existing plants, application may be difficult due to the space requirements
g	Maintain furnace sealing	Generally applicable

a Descriptions of the techniques are given in Section 1.10.

h	Maintain the temperature in the furnace at the lowest required level	Generally applicable
i	Apply a hood at the tapping point, ladles and drossing area with an air extraction system	Generally applicable
j	Pretreatment of dusty raw material, such as pelletisation	Applicable only when the process and the furnace can use pelletised raw materials
k	Apply a doghouse for ladles during tapping	Generally applicable
l	An air extraction system for charging and tapping area connected to a filtration system	Generally applicable

a Descriptions of the techniques are given in Section 1.10.

BAT 93. In order to prevent or reduce diffuse emissions from remelting, refining and casting in primary and secondary lead and/or tin production, BAT is to use a combination of the techniques given below.

	Technique
a	Hood on the crucible furnace or kettle with an air extraction system
b	Lids to close the kettle during the refining reactions and addition of chemicals
c	Hood with air extraction system at launders and tapping points
d	Temperature control of the melt
e	Closed mechanical skimmers for removal of dusty dross/residues

1.4.1.2. *Channelled dust emissions*

BAT 94. In order to reduce dust and metal emissions to air from raw material preparation (such as reception, handling, storage, metering, mixing, blending, drying, crushing, cutting and screening) in primary and secondary lead/or and tin production, BAT is to use a bag filter.

BAT-associated emission levels: See Table 22.

TABLE 22

BAT-associated emission levels for dust emissions to air from raw material preparation in primary and secondary lead and/or tin production

Parameter	BAT-AEL (mg/Nm^3)[a]
Dust	≤ 5
a As a daily average or as an average over the sampling period.	

The associated monitoring is in BAT 10.

BAT 95. In order to reduce dust and metal emissions to air from battery preparation (crushing, screening and classifying), BAT is to use a bag filter or a wet scrubber.

BAT-associated emission levels: See Table 23.

TABLE 23

BAT-associated emission levels for dust emissions to air from battery preparation (crushing, screening and classifying)

Parameter	BAT-AEL (mg/Nm^3)[a]
Dust	≤ 5
a As an average over the sampling period.	

The associated monitoring is in BAT 10.

BAT 96. In order to reduce dust and metal emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant) from charging, smelting and tapping in primary and secondary lead and/or tin production, BAT is to use a bag filter.

BAT-associated emission levels: See Table 24.

TABLE 24

BAT-associated emission levels for dust and lead emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant) from charging, smelting and tapping in primary and secondary lead and/or tin production

Parameter	BAT-AEL (mg/Nm^3)
Dust	2-4[ab]
Pb	≤ 1[c]
a As a daily average or as an average over the sampling period.	
b Dust emissions are expected to be towards the lower end of the range when emissions are above the following levels: 1 mg/Nm^3 for copper, 0,05 mg/Nm^3 for arsenic, 0,05 mg/Nm^3 for cadmium.	
c As an average over the sampling period.	

The associated monitoring is in BAT 10.

BAT 97. In order to reduce dust and metal emissions to air from remelting, refining and casting in primary and secondary lead and/or tin production, BAT is to use the techniques given below.

	Technique
a	For pyrometallurgical processes: maintain the temperature of the melt bath at the lowest

	possible level according to the process stage in combination with a bag filter
b	For hydrometallurgical processes: use a wet scrubber

BAT-associated emission levels: See Table 25.

TABLE 25

BAT-associated emission levels for dust and lead emissions to air from remelting, refining and casting in primary and secondary lead and/or tin production

Parameter	**BAT-AEL (mg/Nm^3)**
Dust	2-4[ab]
Pb	≤ 1[c]

a As a daily average or as an average over the sampling period.

b Dust emissions are expected to be towards the lower end of the range when emissions are above the following levels: 1 mg/Nm^3 for copper, 1 mg/Nm^3 for antimony, 0,05 mg/Nm^3 for arsenic, 0,05 mg/Nm^3 for cadmium.

c As an average over the sampling period.

The associated monitoring is in BAT 10.

1.4.1.3. *Organic compound emissions*

BAT 98. In order to reduce emissions of organic compounds to air from the raw material drying and smelting process in secondary lead and/or tin production, BAT is to use one or a combination of the techniques given below.

	Technique[a]	**Applicability**
a	Select and feed the raw materials according to the furnace and the abatement techniques used	Generally applicable
b	Optimise combustion conditions to reduce the emissions of organic compounds	Generally applicable
c	Afterburner or regenerative thermal oxidiser	The applicability is restricted by the energy content of the off-gases that need to be treated, as off-gases with a lower energy content lead to a higher use of fuels

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 26.

TABLE 26

BAT-associated emission levels for TVOC emissions to air from the raw material drying and smelting process in secondary lead and/or tin production

Parameter	BAT-AEL (mg/Nm^3)[a]
TVOC	10-40

a As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 99. In order to reduce PCDD/F emissions to air from the smelting of secondary lead and/or tin raw materials, BAT is to use one or a combination of the techniques given below.

Technique	
a	Select and feed the raw materials according to the furnace and the abatement techniques used[a]
b	Use charging systems, for a semi-closed furnace, to give small additions of raw material[a]
c	Internal burner system[a] for melting furnaces
d	Afterburner or regenerative thermal oxidiser[a]
e	Avoid exhaust systems with a high dust build-up at temperatures > 250 °C[a]
f	Rapid quenching[a]
g	Injection of adsorption agent in combination with efficient dust collection system[a]
h	Use of efficient dust collection system
i	Use of oxygen injection in the upper zone of the furnace
j	Optimise combustion conditions to reduce the emissions of organic compounds[a]

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 27.

TABLE 27

BAT-associated emission levels for PCDD/F emissions to air from the smelting of secondary lead and/or tin raw materials

Parameter	BAT-AEL (ng I-TEQ/Nm^3)[a]
PCDD/F	≤ 0,1

a As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.4.1.4. *Sulphur dioxide emissions*

BAT 100. In order to prevent or reduce SO_2 emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant) from charging, smelting and tapping in primary and secondary lead and/or tin production, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Alkaline leaching of raw materials that contain sulphur in the form of sulphate	Generally applicable
b	Dry or semi-dry scrubber[a]	Generally applicable
c	Wet scrubber[a]	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)
d	Fixation of sulphur in the smelt phase	Only applicable for secondary lead production

a Descriptions of the techniques are given in Section 1.10.

Description

BAT 100(a): An alkali salt solution is used to remove sulphates from secondary materials prior to smelting.

BAT 100(d): The fixation of sulphur in the smelt phase is achieved by adding iron and soda (Na_2CO_3) in the smelters which react with the sulphur contained in the raw materials to form Na_2S-FeS slag.

BAT-associated emission levels: See Table 28.

TABLE 28

BAT-associated emission levels for SO_2 emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant) from charging, smelting and tapping in primary and secondary lead and/or tin production

Parameter	BAT-AEL (mg/Nm^3)[ab]

a As a daily average or as an average over the sampling period.

b When wet scrubbers are not applicable, the upper end of the range is 500 mg/Nm^3.

SO_2	50-350
a As a daily average or as an average over the sampling period.	
b When wet scrubbers are not applicable, the upper end of the range is 500 mg/Nm[3].	

The associated monitoring is in BAT 10.

1.4.2. **Soil and groundwater protection**

BAT 101. In order to prevent the contamination of soil and groundwater from battery storage, crushing, screening and classifying operations, BAT is to use an acid-resistant floor surface and a system for the collection of acid spillages.

1.4.3. **Waste water generation and treatment**

BAT 102. In order to prevent the generation of waste water from the alkaline leaching process, BAT is to reuse the water from the sodium sulphate crystallisation of the alkali salt solution.

BAT 103. In order to reduce emissions to water from battery preparation when the acid mist is sent to the waste water treatment plant, BAT is to operate an adequately designed waste water treatment plant to abate the pollutants contained in this stream.

1.4.4. **Waste**

BAT 104. In order to reduce the quantities of waste sent for disposal from primary lead production, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique	**Applicability**
a	Reuse of the dust from the dust removal system in the lead production process	Generally applicable
b	Se and Te recovery from wet or dry gas cleaning dust/sludge	The applicability can be limited by the quantity of mercury present
c	Ag, Au, Bi, Sb and Cu recovery from the refining dross	Generally applicable
d	Recovery of metals from the waste water treatment sludge	Direct smelting of the waste water treatment plant sludge might be limited by the presence of elements such as As, Tl and Cd
e	Addition of flux materials that make the slag more suitable for external use	Generally applicable

BAT 105. In order to allow the recovery of the polypropylene and polyethylene content of the lead battery, BAT is to separate it from the batteries prior to smelting.

Applicability

This may not be applicable for shaft furnaces due to the gas permeability provided by undismantled (whole) batteries, which is required by the furnace operations.

BAT 106. In order to reuse or recover the sulphuric acid collected from the battery recovery process, BAT is to organise operations on site so as to facilitate its internal or external reuse or recycling, including one or a combination of the techniques given below.

	Technique	Applicability
a	Reuse as a pickling agent	Generally applicable depending on the local conditions such as presence of the pickling process and compatibility of the impurities present in the acid with the process
b	Reuse as raw material in a chemical plant	Applicability may be restricted depending on the local availability of a chemical plant
c	Regeneration of the acid by cracking	Only applicable when a sulphuric acid or liquid sulphur dioxide plant is present
d	Production of gypsum	Only applicable if the impurities present in the recovery acid do not affect the gypsum quality or if gypsum of a lower quality can be used for other purposes such as a flux agent
e	Production of sodium sulphate	Only applicable for the alkaline leaching process

BAT 107. In order to reduce the quantities of waste sent for disposal from secondary lead and/or tin production, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique
a	Reuse the residues in the smelting process to recover lead and other metals
b	Treat the residues and the wastes in dedicated plants for material recovery
c	Treat the residues and the wastes so that they can be used for other applications

1.5. BAT CONCLUSIONS FOR ZINC AND/OR CADMIUM PRODUCTION

1.5.1. **Primary zinc production**

1.5.1.1. *Hydrometallurgical zinc production*

1.5.1.1.1. *Energy*

BAT 108. In order to use energy efficiently, BAT is to recover heat from the off-gases produced in the roaster using one or a combination of the techniques given below.

	Technique	Applicability
a	Use a waste heat boiler and turbines to produce electricity	Applicability may be restricted depending on energy prices and the energy policy of the Member State
b	Use a waste heat boiler and turbines to produce mechanical energy to be used within the process	Generally applicable
c	Use a waste heat boiler to produce heat to be used within the process and/or for office heating	Generally applicable

1.5.1.1.2. *Air emissions*

1.5.1.1.2. Diffuse emissions

BAT 109. In order to reduce diffuse dust emissions to air from the roaster feed preparation and the feeding itself, BAT is to use one or both of the techniques given below.

	Technique
a	Wet feeding
b	Completely enclosed process equipment connected to an abatement system

BAT 110. In order to reduce diffuse dust emissions to air from calcine processing, BAT is to use one or both of the techniques given below.

	Technique
a	Perform operations under negative pressure
b	Completely enclosed process equipment connected to an abatement system

BAT 111. In order to reduce diffuse emissions to air from leaching, solid-liquid separation and purification, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Cover tanks with a lid	Generally applicable
b	Cover process liquid inlet and outlet launders	Generally applicable
c	Connect tanks to a central mechanical draught abatement system or to a single tank abatement system	Generally applicable
d	Cover vacuum filters with hoods and connect them to an abatement system	Only applicable to the filtering of hot liquids in the leaching and solid-liquid separation stages

BAT 112. In order to reduce diffuse emissions to air from electrowinning, BAT is to use additives, especially foaming agents, in the electrowinning cells.

1.5.1.1.2.2. Channelled emissions

BAT 113. In order to reduce dust and metal emissions to air from the handling and storage of raw materials, dry roaster feed preparation, dry roaster feeding and calcine processing, BAT is to use a bag filter.

BAT-associated emission levels: See Table 29.

TABLE 29

BAT-associated emission levels for dust emissions to air from the handling and storage of raw materials, dry roaster feed preparation, dry roaster feeding and calcine processing

Parameter	BAT-AEL (mg/Nm^3)[a]
Dust	≤ 5

a As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 114. In order to reduce zinc and sulphuric acid emissions to air from leaching, purification and electrolysis, and to reduce arsane and stibane emissions from purification, BAT is to use one or a combination of the techniques given below.

	Technique[a]
a	Wet scrubber
b	Demister
c	Centrifugal system

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 30.

TABLE 30

BAT-associated emission levels for zinc and sulphuric acid emissions to air from leaching, purification and electrolysis and for arsane and stibane emissions from purification

Parameter	BAT-AEL (mg/Nm^3)[a]
Zn	≤ 1
H_2SO_4	< 10
Sum of AsH_3 and SbH_3	≤ 0,5

a As an average over the sampling period.

The associated monitoring is in BAT 10.

1.5.1.1.3. *Soil and groundwater protection*

BAT 115. In order to prevent soil and groundwater contamination, BAT is to use a watertight bunded area for tanks used during leaching or purification and a secondary containment system of the cell houses.

1.5.1.1.4. *Waste water generation*

BAT 116. In order to reduce fresh water consumption and prevent the generation of waste water, BAT is to use a combination of the techniques given below.

	Technique
a	Return of the bleed from the boiler and the water from the closed cooling circuits of the roaster to the wet gas cleaning or the leaching stage
b	Return of the waste water from the cleaning operations/spills of the roaster, the electrolysis and the casting to the leaching stage
c	Return of the waste water from the cleaning operations/spills of the leaching and purification, the filter cake washing and the wet gas scrubbing to the leaching and/or purification stages

1.5.1.1.5. *Waste*

BAT 117. In order to reduce the quantities of waste sent for disposal, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique	Applicability
a	Reuse of the dust collected in the concentrate storage and handling within the process	Generally applicable

	(together with the concentrate feed)	
b	Reuse of the dust collected in the roasting process via the calcine silo	Generally applicable
c	Recycling of residues containing lead and silver as raw material in an external plant	Applicable depending on the metal content and on the availability of a market/ process
d	Recycling of residues containing Cu, Co, Ni, Cd, Mn as raw material in an external plant to obtain a saleable product	Applicable depending on the metal content and on the availability of a market/ process

BAT 118. In order to make the leaching waste suitable for final disposal, BAT is to use one of the techniques given below.

	Technique	**Applicability**
a	Pyrometallurgical treatment in a Waelz kiln	Only applicable to neutral leaching wastes that do not contain too many zinc ferrites and/or do not contain high concentrations of precious metals
b	Jarofix process	Only applicable to jarosite iron residues. Limited applicability due to an existing patent
c	Sulphidation process	Only applicable to jarosite iron residues and direct leach residues
d	Compacting iron residues	Only applicable to goethite residues and gypsum-rich sludge from the waste water treatment plant

Description

BAT 118(b): The Jarofix process consists of mixing jarosite precipitates with Portland cement, lime and water.

BAT 118(c): The sulphidation process consists of the addition of NaOH and Na_2S to the residues in an elutriating tank and in sulphidation reactors.

BAT 118(d): Compacting iron residues consists of reducing the moisture content by means of filters and the addition of lime or other agents.

1.5.1.2. *Pyrometallurgical zinc production*

1.5.1.2.1. *Air emissions*

1.5.1.2.1.1. Channelled dust emissions

BAT 119. In order to reduce dust and metal emissions to air (other than those that are routed to the sulphuric acid plant) from pyrometallurgical zinc production, BAT is to use a bag filter.

Applicability

In the event of a high organic carbon content in the concentrates (e.g. around 10 wt-%), bag filters might not be applicable due to the blinding of the bags and other techniques (e.g. wet scrubber) might be used.

BAT-associated emission levels: See Table 31.

TABLE 31

BAT-associated emission levels for dust emissions to air (other than those that are routed to the sulphuric acid plant) from pyrometallurgical zinc production

Parameter	BAT-AEL (mg/Nm^3)[a][b]
Dust	2-5
a As a daily average or as an average over the sampling period.	
b When a bag filter is not applicable, the upper end of the range is 10 mg/Nm^3.	

The associated monitoring is in BAT 10.

BAT 120. In order to reduce SO_2 emissions to air (other than those that are routed to the sulphuric acid plant) from pyrometallurgical zinc production, BAT is to use a wet desulphurisation technique.

BAT-associated emission levels: See Table 32.

TABLE 32

BAT-associated emission levels for SO_2 emissions to air (other than those that are routed to the sulphuric acid plant) from pyrometallurgical zinc production

Parameter	BAT-AEL (mg/Nm^3)[a]
SO_2	≤ 500
a As a daily average.	

The associated monitoring is in BAT 10.

1.5.2. **Secondary zinc production**

1.5.2.1. *Air emissions*

1.5.2.1.1. *Channelled dust emissions*

BAT 121. In order to reduce dust and metal emissions to air from pelletising and slag processing, BAT is to use a bag filter.

BAT-associated emission levels: See Table 33.

TABLE 33

BAT-associated emission levels for dust emissions to air from pelletising and slag processing

Parameter	BAT-AEL (mg/Nm^3)[a]
Dust	≤ 5

a As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 122. In order to reduce dust and metal emissions to air from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln, BAT is to use a bag filter.

Applicability

A bag filter may not be applicable for a clinker operation (where chlorides need to be abated instead of metal oxides).

BAT-associated emission levels: See Table 34.

TABLE 34

BAT-associated emission levels for dust emissions to air from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln

Parameter	BAT-AEL (mg/Nm^3)[abc]
Dust	2-5

a As a daily average or as an average over the sampling period.

b When a bag filter is not applicable, the upper end of the range may be higher, up to 15 mg/Nm^3.

c Dust emissions are expected to be towards the lower end of the range when emissions of arsenic or cadmium are above 0,05 mg/Nm^3.

The associated monitoring is in BAT 10.

1.5.2.1.2. *Organic compound emissions*

BAT 123. In order to reduce emissions of organic compounds to air from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln, BAT is to use one or a combination of the techniques given below.

	Technique[a]	Applicability
a	Injection of adsorbent (activated carbon or lignite coke) followed by a bag filter and/or ESP	Generally applicable
b	Thermal oxidiser	Generally applicable
c	Regenerative thermal oxidiser	May not be applicable due to safety reasons

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 35.

TABLE 35

BAT-associated emission levels for emissions to air of TVOC and PCDD/F from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln

Parameter	Unit	BAT-AEL
TVOC	mg/Nm^3	2-20[a]
PCDD/F	ng $I\text{-}TEQ/Nm^3$	≤ 0,1[b]

a As a daily average or as an average over the sampling period.

b As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.5.2.1.3. *Acid emissions*

BAT 124. In order to reduce emissions of HCl and HF to air from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln, BAT is to use one of the techniques given below.

	Technique[a]	Process
a	Injection of adsorbent followed by a bag filter	— Melting of metallic and mixed metallic/oxidic streams — Waelz kiln
b	Wet scrubber	— Slag fuming furnace

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 36.

TABLE 36

BAT-associated emission levels for emissions of HCl and HF to air from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln

Parameter	BAT-AEL (mg/Nm^3)[a]
HCl	≤ 1,5
HF	≤ 0,3

a As an average over the sampling period.

The associated monitoring is in BAT 10.

1.5.2.2. *Waste water generation and treatment*

BAT 125. In order to reduce the consumption of fresh water in the Waelz kiln process, BAT is to use multiple-stage countercurrent washing.

Description

Water coming from a previous washing stage is filtered and reused in the following washing stage. Two or three stages can be used, allowing up to three times less water consumption in comparison with single-stage countercurrent washing.

BAT 126. In order to prevent or reduce halide emissions to water from the washing stage in the Waelz kiln process, BAT is to use crystallisation.

1.5.3. Melting, alloying and casting of zinc ingots and zinc powder production

1.5.3.1. *Air emissions*

1.5.3.1.1. *Diffuse dust emissions*

BAT 127. In order to reduce diffuse dust emissions to air from the melting, alloying and casting of zinc ingots, BAT is to use equipment under negative pressure.

1.5.3.1.2. *Channelled dust emissions*

BAT 128. In order to reduce dust and metal emissions to air from the melting, alloying and casting of zinc ingots and zinc powder production, BAT is to use a bag filter.

BAT-associated emission levels: See Table 37.

TABLE 37

BAT-associated emission levels for dust emissions to air from the melting, alloying and casting of zinc ingots and zinc powder production

Parameter	BAT-AEL (mg/Nm^3)[a]
Dust	≤ 5

a As an average over the sampling period.

The associated monitoring is in BAT 10.

1.5.3.2. *Waste water*

BAT 129. In order to prevent the generation of waste water from the melting and casting of zinc ingots, BAT is to reuse the cooling water.

1.5.3.3. *Waste*

BAT 130. In order to reduce the quantities of waste sent for disposal from the melting of zinc ingots, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or both of the techniques given below.

	Technique
a	Use of the oxidised fraction of the zinc dross and the zinc-bearing dust from the melting furnaces in the roasting furnace or in the hydrometallurgical zinc production process
b	Use of the metallic fraction of the zinc dross and the metallic dross from cathode casting in the melting furnace or recovery as zinc dust or zinc oxide in a zinc refining plant

1.5.4. Cadmium production

1.5.4.1. *Air emissions*

1.5.4.1.1. *Diffuse emissions*

BAT 131. In order to reduce diffuse emissions to air, BAT is to use one or both of the techniques given below.

	Technique
a	Central extraction system connected to an abatement system for leaching and solid-liquid separation in hydrometallurgical production; for briquetting/pelletising and fuming in pyrometallurgical production; and for melting, alloying and casting processes
b	Cover cells for the electrolysis stage in hydrometallurgical production

1.5.4.1.2. *Channelled dust emissions*

BAT 132. In order to reduce dust and metal emissions to air from pyrometallurgical cadmium production and the melting, alloying and casting of cadmium ingots, BAT is to use one or a combination of the techniques given below.

	Technique[a]	Applicability
a	Bag filter	Generally applicable
b	ESP	Generally applicable
c	Wet scrubber	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 38.

TABLE 38

BAT-associated emission levels for dust and cadmium emissions to air from pyrometallurgical cadmium production and the melting, alloying and casting of cadmium ingots

Parameter	BAT-AEL (mg/Nm^3)[a]
Dust	2-3
Cd	≤ 0,1

a As an average over the sampling period.

The associated monitoring is in BAT 10.

1.5.4.2. *Waste*

BAT 133. In order to reduce the quantities of waste sent for disposal from hydrometallurgical cadmium production, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one of the techniques given below.

	Technique	Applicability
a	Extract the cadmium from the zinc process as a cadmium-rich cementate in the purification section, further concentrate and refine it (by electrolysis or a pyrometallurgical process) and finally transform it into marketable cadmium metal or cadmium compounds	Only applicable if an economically viable demand exists
b	Extract the cadmium from the zinc process as a cadmium-rich cementate in the purification section, and then apply a set of hydrometallurgical operations in order to obtain a cadmium-rich precipitate (e.g. cement (Cd metal), $Cd(OH)_2$) that is landfilled, while all other process flows are recycled in the cadmium plant or in the zinc plant flow	Only applicable if suitable landfill is available

1.6. BAT CONCLUSIONS FOR PRECIOUS METALS PRODUCTION

1.6.1. **Air emissions**

1.6.1.1. *Diffuse emissions*

BAT 134. In order to reduce diffuse emissions to air from a pretreatment operation (such as crushing, sieving and mixing), BAT is to use one or a combination of the techniques given below.

	Technique
a	Enclose pretreatment areas and transfer systems for dusty materials
b	Connect pretreatment and handling operations to dust collectors or extractors via hoods and a ductwork system for dusty materials
c	Electrically interlock pretreatment and handling equipment with their dust collector or extractor, in order to ensure that no equipment may be operated unless the dust collector and filtering system are in operation

BAT 135. In order to reduce diffuse emissions to air from smelting and melting (both Doré and non-Doré operations), BAT is to use all of the techniques given below.

	Technique
a	Enclose buildings and/or smelting furnace areas
b	Perform operations under negative pressure
c	Connect furnace operations to dust collectors or extractors via hoods and a ductwork system
d	Electrically interlock furnace equipment with their dust collector or extractor, in order to ensure that no equipment may be operated unless the dust collector and filtering system are in operation

BAT 136. In order to reduce diffuse emissions to air from leaching and gold electrolysis, BAT is to use one or a combination of the techniques given below.

	Technique
a	Closed tanks/vessels and closed pipes for transfer of solutions
b	Hoods and extraction systems for electrolytic cells
c	Water curtain for gold production, to prevent chlorine gas emissions during the leaching of anode slimes with hydrochloric acid or other solvents

BAT 137. In order to reduce diffuse emissions from a hydrometallurgical operation, BAT is to use all of the techniques given below.

	Technique
a	Containment measures, such as sealed or enclosed reaction vessels, storage tanks, solvent extraction equipment and filters, vessels and tanks fitted with level control, closed pipes, sealed drainage systems, and planned maintenance programmes
b	Reaction vessels and tanks connected to a common ductwork system with off-gas extraction (automatic standby/back-up unit available in case of failure)

BAT 138. In order to reduce diffuse emissions to air from incineration, calcining and drying, BAT is to use all of the techniques given below.

	Technique
a	Connect all calcining furnaces, incinerators and drying ovens to a ductwork system extracting process exhaust gases
b	Scrubber plant on a priority electricity circuit which is served by a back-up generator in the event of power failure
c	Operating start-up and shutdown, spent acid disposal, and fresh acid make-up of scrubbers via an automated control system

BAT 139. In order to reduce diffuse emissions to air from the melting of final metal products during refining, BAT is to use both of the techniques given below.

	Technique
a	Enclosed furnace with negative pressure
b	Appropriate housing, enclosures and capture hoods with efficient extraction/ventilation

1.6.1.2. *Channelled dust emissions*

BAT 140. In order to reduce dust and metal emissions to air from all dusty operations, such as crushing, sieving, mixing, melting, smelting, incineration, calcining, drying and refining, BAT is to use one of the techniques given below.

	Technique[a]	Applicability

a Descriptions of the techniques are given in Section 1.10.

a	Bag filter	May not be applicable for off-gases containing a high level of volatilised selenium
b	Wet scrubber in combination with an ESP, allowing the recovery of selenium	Only applicable to off-gases containing volatilised selenium (e.g. Doré metal production)

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 39.

TABLE 39

BAT-associated emission levels for dust emissions to air from all dusty operations, such as crushing, sieving, mixing, melting, smelting, incineration, calcining, drying and refining

Parameter	**BAT-AEL (mg/Nm^3)**[a]
Dust	2-5

a As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

1.6.1.3. *NO_X emissions*

BAT 141. In order to reduce NO_X emissions to air from a hydrometallurgical operation involving dissolving/leaching with nitric acid, BAT is to use one or both of the techniques given below.

	Technique[a]
a	Alkaline scrubber with caustic soda
b	Scrubber with oxidation agents (e.g. oxygen, hydrogen peroxide) and reducing agents (e.g. nitric acid, urea) for those vessels in hydrometallurgical operations with the potential to generate high concentrations of NO_X. It is often applied in combination with BAT 141(a)

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 40.

TABLE 40

BAT-associated emission levels for NO_X emissions to air from a hydrometallurgical operation involving dissolving/leaching with nitric acid

Parameter	**BAT-AEL (mg/Nm^3)**[a]
NO_X	70-150

a As an hourly average or as an average over the sampling period.

The associated monitoring is in BAT 10.

1.6.1.4. *Sulphur dioxide emissions*

BAT 142. In order to reduce SO_2 emissions to air (other than those that are routed to the sulphuric acid plant) from a melting and smelting operation for the production of Doré metal, including the associated incineration, calcining and drying operations, BAT is to use one or a combination of the techniques given below.

	Technique[a]	Applicability
a	Lime injection in combination with a bag filter	Generally applicable
b	Wet scrubber	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 41.

TABLE 41

BAT-associated emission levels for SO_2 emissions to air (other than those that are routed to the sulphuric acid plant) from a melting and smelting operation for the production of Doré metal, including the associated incineration, calcining and drying operations

Parameter	BAT-AEL (mg/Nm^3)[a]
SO_2	50-480

a As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 143. In order to reduce SO_2 emissions to air from a hydrometallurgical operation, including the associated incineration, calcining and drying operations, BAT is to use a wet scrubber.

BAT-associated emission levels: See Table 42.

TABLE 42

BAT-associated emission levels for SO_2 emissions to air from a hydrometallurgical operation, including the associated incineration, calcining and drying operations

Parameter	BAT-AEL (mg/Nm^3)[a]
SO_2	50-100

a As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

1.6.1.5. *HCl and Cl_2 emissions*

BAT 144. In order to reduce HCl and Cl_2 emissions to air from a hydrometallurgical operation, including the associated incineration, calcining and drying operations, BAT is to use an alkaline scrubber.

BAT-associated emission levels: See Table 43.

TABLE 43

BAT-associated emission levels for HCl and Cl_2 emissions to air from a hydrometallurgical operation, including the associated incineration, calcining and drying operations

Parameter	BAT-AEL (mg/Nm^3)[a]
HCl	≤ 5-10
Cl_2	0,5-2

a As an average over the sampling period.

The associated monitoring is in BAT 10.

1.6.1.6. *NH_3 emissions*

BAT 145. In order to reduce NH_3 emissions to air from a hydrometallurgical operation using ammonia or ammonium chloride, BAT is to use a wet scrubber with sulphuric acid.

BAT-associated emission levels: See Table 44.

TABLE 44

BAT-associated emission levels for NH_3 emissions to air from a hydrometallurgical operation using ammonia or ammonium chloride

Parameter	BAT-AEL (mg/Nm^3)[a]
NH_3	1-3

a As an average over the sampling period.

The associated monitoring is in BAT 10.

1.6.1.7. *PCDD/F emissions*

BAT 146. In order to reduce PCDD/F emissions to air from a drying operation where the raw materials contain organic compounds, halogens or other PCDD/F precursors, from an incineration operation, and from a calcining operation, BAT is to use one or a combination of the techniques given below.

	Technique
a	Afterburner or regenerative thermal oxidiser[a]
b	Injection of adsorption agent in combination with an efficient dust collection system[a]
c	Optimise combustion or process conditions for the abatement of emissions of organic compounds[a]
d	Avoid exhaust systems with a high dust build-up for temperatures > 250 °C[a]
e	Rapid quenching[a]
f	Thermal destruction of PCDD/F in the furnace at high temperatures (> 850 °C)
g	Use of oxygen injection in the upper zone of the furnace
h	Internal burner system[a]

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 45.

TABLE 45

BAT-associated emission levels for PCDD/F emissions to air from a drying operation where the raw materials contain organic compounds, halogens or other PCDD/F precursors, from an incineration operation, and from a calcining operation

Parameter	BAT-AEL (ng I-TEQ/Nm^3)[a]
PCDD/F	≤ 0,1

a As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.6.2. **Soil and groundwater protection**

BAT 147. In order to prevent soil and groundwater contamination, BAT is to use a combination of the techniques given below.

	Technique
a	Use of sealed drainage systems
b	Use of double-walled tanks or placement in resistant bunds
c	Use of impermeable and acid-resistant floors
d	Automatic level control of reaction vessels

1.6.3. **Waste water generation**

BAT 148. In order to prevent the generation of waste water, BAT is to use one or both of the techniques given below.

	Technique
a	Recycling of spent/recovered scrubbing liquids and other hydrometallurgical reagents in leaching and other refining operations
b	Recycling of solutions from leaching, extraction and precipitation operations

1.6.4. **Waste**

BAT 149. In order to reduce the quantities of waste sent for disposal, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique	Process
a	Recovery of the metal content from slags, filter dust and residues of the wet dedusting system	Doré production
b	Recovery of the selenium collected in the wet dedusting system's off-gases containing volatilised selenium	
c	Recovery of silver from spent electrolyte and spent slime washing solutions	Silver electrolytic refining
d	Recovery of metals from residues from electrolyte purification (e.g. silver cement, copper carbonate-based residue)	
e	Recovery of gold from electrolyte, slimes and solutions from the gold leaching processes	Gold electrolytic refining
f	Recovery of metals from spent anodes	Silver or gold electrolytic refining
g	Recovery of platinum group metals from platinum group metal-enriched solutions	
h	Recovery of metals from the treatment of process end liquors	All processes

1.7. BAT CONCLUSIONS FOR FERRO-ALLOYS PRODUCTION

1.7.1. **Energy**

BAT 150. In order to use energy efficiently, BAT is to recover energy from the CO-rich exhaust gas generated in a closed submerged arc furnace or in a closed plasma dust process using one or a combination of the techniques given below.

	Technique	Applicability
a	Use of a steam boiler and turbines to recover the energy content of the exhaust gas and produce electricity	Applicability may be restricted depending on energy prices and the energy policy of the Member State
b	Direct use of the exhaust gas as fuel within the process (e.g. for drying raw materials, preheating charging materials, sintering, heating of ladles)	Only applicable if a demand for process heat exists
c	Use of the exhaust gas as fuel in neighbouring plants	Only applicable if an economically viable demand for this type of fuel exists

BAT 151. In order to use energy efficiently, BAT is to recover energy from the hot exhaust gas generated in a semi-closed submerged arc furnace using one or both of the techniques given below.

	Technique	Applicability
a	Use of a waste heat boiler and turbines to recover the energy content of the exhaust gas and produce electricity	Applicability may be restricted depending on energy prices and the energy policy of the Member State
b	Use of a waste heat boiler to produce hot water	Only applicable if an economically viable demand exists

BAT 152. In order to use energy efficiently, BAT is to recover energy from the exhaust gas generated in an open submerged arc furnace via the production of hot water.

Applicability

Only applicable if an economically viable demand for hot water exists.

1.7.2. **Air emissions**

1.7.2.1. *Diffuse dust emissions*

BAT 153. In order to prevent or reduce and collect diffuse emissions to air from tapping and casting, BAT is to use one or both of the techniques given below.

	Technique	Applicability

a	Use of a hooding system	For existing plants, applicable depending on the configuration of the plant
b	Avoid casting by using ferro-alloys in the liquid state	Only applicable when the consumer (e.g. steel producer) is integrated with the ferro-alloy producer

1.7.2.2. *Channelled dust emissions*

BAT 154. In order to reduce dust and metal emissions to air from the storage, handling and transport of solid materials, and from pretreatment operations such as metering, mixing, blending and degreasing, and from tapping, casting and packaging, BAT is to use a bag filter.

BAT-associated emission levels: See Table 46.

BAT 155. In order to reduce dust and metal emissions to air from crushing, briquetting, pelletising and sintering, BAT is to use a bag filter or a bag filter in combination with other techniques.

Applicability

The applicability of a bag filter may be limited in the case of low ambient temperatures (– 20 °C to – 40 °C) and high humidity of the off-gases, as well as for the crushing of CaSi due to safety concerns (i.e. explosivity).

BAT-associated emission levels: See Table 46.

BAT 156. In order to reduce dust and metal emissions to air from an open or a semi-closed submerged arc furnace, BAT is to use a bag filter.

BAT-associated emission levels: See Table 46.

BAT 157. In order to reduce dust and metal emissions to air from a closed submerged arc furnace or a closed plasma dust process, BAT is to use one of the techniques given below.

	Technique[a]	**Applicability**
a	Wet scrubber in combination with an ESP	Generally applicable
b	Bag filter	Generally applicable unless safety concerns exist related to the CO and H_2 content in the exhaust gases

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 46.

BAT 158. In order to reduce dust and metal emissions to air from a refractory-lined crucible for the production of ferro-molybdenum and ferro-vanadium, BAT is to use a bag filter.

BAT-associated emission levels: See Table 46.

TABLE 46

BAT-associated emission levels for dust emissions to air from ferro-alloys production

Parameter	Process	BAT-AEL (mg/Nm^3)
Dust	— Storage, handling and transport of solid materials — Pretreatment operations such as metering, mixing, blending and degreasing — Tapping, casting and packaging	2-5[a]
	Crushing, briquetting, pelletising and sintering	2-5[bc]
	Open or semi-closed submerged arc furnace	2-5[bde]
	— Closed submerged arc furnace or closed plasma dust process — Refractory-lined crucible for the production of ferro-molybdenum and ferro-vanadium	2-5[b]

a As an average over the sampling period.

b As a daily average or as an average over the sampling period.

c The upper end of the range can be up to 10 mg/Nm^3 for cases where a bag filter cannot be used.

d The upper end of the range may be up to 15 mg/Nm^3 for the production of FeMn, SiMn, CaSi due to the sticky nature of the dust (caused e.g. by its hygroscopic capacity or chemical characteristics) affecting the efficiency of the bag filter.

e Dust emissions are expected to be towards the lower end of the range when emissions of metals are above the following levels: 1 mg/Nm^3 for lead, 0,05 mg/Nm^3 for cadmium, 0,05 mg/Nm^3 for chromium^{VI}, 0,05 mg/Nm^3 for thallium.

The associated monitoring is in BAT 10.

1.7.2.3. *PCDD/F emissions*

BAT 159. In order to reduce PCDD/F emissions to air from a furnace producing ferro-alloys, BAT is to inject adsorbents and to use an ESP and/or a bag filter.

BAT-associated emission levels: See Table 47.

TABLE 47

BAT-associated emission levels for PCDD/F emissions to air from a furnace producing ferro-alloys

Parameter	BAT-AEL (ng I-TEQ/Nm^3)
PCDD/F	≤ 0,05[a]

a As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.7.2.4. *PAH and organic compound emissions*

BAT 160. In order to reduce PAH and organic compound emissions to air from the degreasing of titanium swarf in rotary kilns, BAT is to use a thermal oxidiser.

1.7.3. **Waste**

BAT 161. In order to reduce the quantities of slag sent for disposal, BAT is to organise operations on site so as to facilitate slag reuse or, failing that, slag recycling, including by using one or a combination of the techniques given below.

	Technique	Applicability
a	Use of slag in construction applications	Only applicable to slags from high-carbon FeCr and SiMn production, slags from alloy recovery from steel mill residues and standard exhaust slag from FeMn and FeMo production
b	Use of slag as sandblasting grit	Only applicable to slags from high-carbon FeCr production
c	Use of slag for refractory castables	Only applicable to slags from high-carbon FeCr production
d	Use of slag in the smelting process	Only applicable to slags from silico-calcium production
e	Use of slag as raw material for the production of silico-manganese or other metallurgical applications	Only applicable to rich slag (high content of MnO) from FeMn production

BAT 162. In order to reduce the quantities of filter dust and sludge sent for disposal, BAT is to organise operations on site so as to facilitate filter dust and sludge reuse or, failing that, filter dust and sludge recycling, including one or a combination of the techniques given below.

	Technique	Applicability[a]
a	Use of filter dust in the smelting process	Only applicable to filter dust from FeCr and FeMo production

a Highly contaminated dusts and sludges cannot be reused or recycled. Reuse and recycling might also be limited by accumulation problems (e.g. reusing dust from FeCr production might lead to Zn accumulation in the furnace).

b	Use of filter dust in stainless steel production	Only applicable to filter dust from crushing and screening operations in high-carbon FeCr production
c	Use of filter dust and sludge as a concentrate feed	Only applicable to filter dust and sludge from the off-gas cleaning in Mo roasting
d	Use of filter dust in other industries	Only applicable to FeMn, SiMn, FeNi, FeMo and FeV production
e	Use of micro-silica as an additive in the cement industry	Only applicable to micro-silica from FeSi and Si production
f	Use of filter dust and sludge in the zinc industry	Only applicable to furnace dust and wet scrubber sludge from the alloy recovery from steel mill residues

a Highly contaminated dusts and sludges cannot be reused or recycled. Reuse and recycling might also be limited by accumulation problems (e.g. reusing dust from FeCr production might lead to Zn accumulation in the furnace).

1.8. BAT CONCLUSIONS FOR NICKEL AND/OR COBALT PRODUCTION

1.8.1. **Energy**

BAT 163. In order to use energy efficiently, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use of oxygen-enriched air in smelting furnaces and oxygen converters
b	Use of heat recovery boilers
c	Use of the flue-gas generated in the furnace within the process (e.g. drying)
d	Use of heat exchangers

1.8.2. **Air emissions**

1.8.2.1. *Diffuse emissions*

BAT 164. In order to reduce diffuse dust emissions to air from the charging of a furnace, BAT is to use enclosed conveyor systems.

BAT 165. In order to reduce diffuse dust emissions to air from smelting, BAT is to use covered and hooded launders connected to an abatement system.

BAT 166. In order to reduce diffuse dust emissions from converting processes, BAT is to use operation under negative pressure and capture hoods connected to an abatement system.

BAT 167. In order to reduce diffuse emissions from atmospheric and pressure leaching, BAT is to use both of the techniques given below.

	Technique
a	Sealed or closed reactors, settlers and pressure autoclaves/vessels
b	Use of oxygen or chlorine instead of air in leaching stages

BAT 168. In order to reduce diffuse emissions from solvent extraction refining, BAT is to use one of the techniques given below.

	Technique
a	Use of a low or a high shear mixer for the solvent/aqueous mixture
b	Use of covers for the mixer and separator
c	Use of completely sealed tanks connected to an abatement system

BAT 169. In order to reduce diffuse emissions from electrowinning, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Collection and reuse of chlorine gas	Only applicable to chloride-based electrowinning
b	Use of polystyrene beads to cover cells	Generally applicable
c	Use of foaming agents to cover the cells with a stable layer of foam	Only applicable to sulphate-based electrowinning

BAT 170. In order to reduce diffuse emissions from the hydrogen reduction process when producing nickel powder and nickel briquettes (pressure processes), BAT is to use a sealed or closed reactor, a settler and a pressure autoclave/vessel, a powder conveyor and a product silo.

1.8.2.2. *Channelled dust emissions*

BAT 171. When processing sulphidic ores, in order to reduce dust and metal emissions to air from the handling and storage of raw materials, material pretreatment processes (such as ore preparation and ore/concentrate drying), furnace charging, smelting, converting, thermal refining and nickel powder and briquette production, BAT is to use a bag filter or a combination of an ESP and a bag filter.

BAT-associated emission levels: See Table 48.

TABLE 48

BAT-associated emission levels for dust emissions to air from the handling and storage of raw materials, material pretreatment processes (such as ore preparation and ore/concentrate drying), furnace charging, smelting, converting, thermal refining and nickel powder and briquette production when processing sulphidic ores

Parameter	BAT-AEL (mg/Nm^3)[a]
Dust	2-5

a As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

1.8.2.3. *Nickel and chlorine emissions*

BAT 172. In order to reduce nickel and chlorine emissions to air from the atmospheric or pressure leaching processes, BAT is to use a wet scrubber.

BAT-associated emission levels: See Table 49.

TABLE 49

BAT-associated emission levels for nickel and chlorine emissions to air from the atmospheric or pressure leaching processes

Parameter	BAT-AEL (mg/Nm^3)[a]
Ni	≤ 1
Cl_2	≤ 1

a As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 173. In order to reduce nickel emissions to air from the nickel matte refining process using ferric chloride with chlorine, BAT is to use a bag filter.

BAT-associated emission levels: See Table 50.

TABLE 50

BAT-associated emission levels for nickel emissions to air from the nickel matte refining process using ferric chloride with chlorine

Parameter	BAT-AEL (mg/Nm^3)[a]
Ni	≤ 1

a As an average over the sampling period.

The associated monitoring is in BAT 10.

1.8.2.4. *Sulphur dioxide emissions*

BAT 174. When processing sulphidic ores, in order to reduce SO_2 emissions to air (other than those that are routed to the sulphuric acid plant) from smelting and converting, BAT is to use one of the techniques given below.

	Technique[a]
a	Lime injection followed by a bag filter
b	Wet scrubber

a Descriptions of the techniques are given in Section 1.10.

1.8.2.5. *NH_3 emissions*

BAT 175. In order to reduce NH_3 emissions to air from nickel powder and briquette production, BAT is to use a wet scrubber.

1.8.3. **Waste**

BAT 176. In order to reduce the quantities of waste sent for disposal, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique	Applicability
a	Use of the granulated slag generated in the electric arc furnace (used in smelting) as an abrasive or construction material	Applicability depends on the metal content of the slag
b	Use of the off-gas dust recovered from the electric arc furnace (used in smelting) as a raw material for zinc production	Generally applicable
c	Use of the matte granulation off-gas dust recovered from the electric arc furnace (used in smelting) as a raw material for the nickel refinery/re-smelting	Generally applicable
d	Use of the sulphur residue obtained after matte filtration in the chlorine-based leaching as a raw material for sulphuric acid production	Generally applicable
e	Use of the iron residue obtained after sulphate-based leaching as a feed to the nickel smelter	Applicability depends on the metal content of the waste
f	Use of the zinc carbonate residue obtained from the solvent extraction refining as a raw material for zinc production	Applicability depends on the metal content of the waste

g	Use of the copper residues obtained after leaching from the sulphate- and chlorine-based leaching as a raw material for copper production	Generally applicable

1.9. BAT CONCLUSIONS FOR CARBON AND/OR GRAPHITE PRODUCTION

1.9.1. **Air emissions**

1.9.1.1. *Diffuse emissions*

BAT 177. In order to reduce diffuse PAH emissions to air from the storage, handling and transport of liquid pitch, BAT is to use one or a combination of the techniques given below.

	Technique
a	Back-venting of the liquid pitch storage tank
b	Condensation by external and/or internal cooling with air and/or water systems (e.g. conditioning towers), followed by filtration techniques (adsorption scrubbers or ESP)
c	Collection and transfer of collected off-gases to abatement techniques (dry scrubber or thermal oxidiser/regenerative thermal oxidiser) available at other stages of the process (e.g. mixing and shaping or baking)

1.9.1.2. *Dust and PAH emissions*

BAT 178. In order to reduce dust emissions to air from the storage, handling and transportation of coke and pitch, and mechanical processes (such as grinding) and graphitising and machining, BAT is to use a bag filter.

BAT-associated emission levels: See Table 51.

TABLE 51

BAT-associated emission levels for dust and BaP (as an indicator of PAH) emissions to air from the storage, handling and transportation of coke and pitch, and mechanical processes (such as grinding) and graphitising and machining

Parameter	**BAT-AEL (mg/Nm^3)**[a]
Dust	2-5
BaP	≤ 0,01[b]
a As an average over the sampling period.	
b BaP particles are only expected if processing solid pitch.	

The associated monitoring is in BAT 10.

BAT 179. In order to reduce dust and PAH emissions to air from the production of green paste and green shapes, BAT is to use one or a combination of the techniques given below.

	Technique[a]
a	Dry scrubber using coke as the adsorbent agent and with or without precooling, followed by a bag filter
b	Coke filter
c	Regenerative thermal oxidiser
d	Thermal oxidiser

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 52.

TABLE 52

BAT-associated emission levels for dust and BaP (as an indicator of PAH) emissions to air from the production of green paste and green shapes

Parameter	**BAT-AEL (mg/Nm^3)**[a]
Dust	2-10[b]
BaP	0,001-0,01

a As an average over the sampling period.

b The lower end of the range is associated with the use of a dry scrubber using coke as the adsorbent agent followed by a bag filter. The upper end of the range is associated with the use of a thermal oxidiser.

The associated monitoring is in BAT 10.

BAT 180. In order to reduce dust and PAH emissions to air from baking, BAT is to use one or a combination of the techniques given below.

	Technique[a]	**Applicability**
a	ESP, in combination with a thermal oxidation step (e.g. regenerative thermal oxidiser) when highly volatile compounds are expected	Generally applicable
b	Regenerative thermal oxidiser, in combination with a pretreatment (e.g. ESP) in cases of a high dust content in the exhaust gas	Generally applicable
c	Thermal oxidiser	Not applicable to continuous ring furnaces

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 53.

TABLE 53

BAT-associated emission levels for dust and BaP (as an indicator of PAH) emissions to air from baking and rebaking

Parameter	BAT-AEL (mg/Nm^3)[a]
Dust	2-10[b]
BaP	0,005-0,015[cd]

a As an average over the sampling period.

b The lower end of the range is associated with the use of a combination of an ESP and a regenerative thermal oxidiser. The higher end of the range is associated with the use of a thermal oxidiser.

c The lower end of the range is associated with the use of a thermal oxidiser. The upper end of the range is associated with the use of a combination of an ESP and a regenerative thermal oxidiser.

d For cathode production, the upper end of the range is 0,05 mg/Nm^3.

The associated monitoring is in BAT 10.

BAT 181. In order to reduce dust and PAH emissions to air from impregnation, BAT is to use one or a combination of the techniques given below.

	Technique[a]
a	Dry scrubber followed by a bag filter
b	Coke filter
c	Thermal oxidiser

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 54.

TABLE 54

BAT-associated emission levels for dust and BaP (as an indicator of PAH) emissions to air from impregnation

Parameter	BAT-AEL (mg/Nm^3)[a]
Dust	2-10
BaP	0,001-0,01

a As an average over the sampling period.

The associated monitoring is in BAT 10.

1.9.1.3. *Sulphur dioxide emissions*

BAT 182. In order to reduce SO_2 emissions to air when there is a sulphur addition in the process, BAT is to use a dry and/or wet scrubber.

1.9.1.4. *Organic compound emissions*

BAT 183. In order to reduce emissions of organic compounds to air, including phenol and the formaldehyde from the impregnation stage where special impregnation agents such as resins and biodegradable solvents are used, BAT is to use one of the techniques given below.

	Technique[a]
a	Regenerative thermal oxidiser in combination with an ESP for the mixing, baking and impregnation stages
b	Biofilter and/or bioscrubber for the impregnation stage where special impregnation agents such as resins and biodegradable solvents are used

a Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 55.

TABLE 55

BAT-associated emission levels for TVOC emissions to air from mixing, baking and impregnation

Parameter	BAT-AEL (mg/Nm^3)[ab]
TVOC	≤ 10-40

a As an average over the sampling period.

b The lower end of the range is associated with the use of an ESP in combination with a regenerative thermal oxidiser. The upper end of the range is associated with the use of a biofilter and/or a bioscrubber.

The associated monitoring is in BAT 10.

1.9.2. **Waste**

BAT 184. In order to reduce the quantities of waste sent for disposal, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by reuse or recycling of carbon and other residues from the production processes within the process or in other external processes.

1.10. DESCRIPTION OF TECHNIQUES

1.10.1. **Air emissions**

The techniques described below are listed according to the main pollutant(s) they are aimed to abate.

1.10.1.1. *Dust emissions*

Technique	Description
Bag filter	Bag filters, often referred to as fabric filters, are constructed from porous woven or felted fabric through which gases flow to remove particles. The use of a bag filter requires a fabric material selection suited to

	the characteristics of the off-gases and the maximum operating temperature.
Electrostatic precipitator (ESP)	Electrostatic precipitators operate such that particles are charged and separated under the influence of an electrical field. They are capable of operating over a wide range of conditions. In a dry ESP, the collected material is mechanically removed (e.g. by shaking, vibration, compressed air), while in a wet ESP it is flushed with a suitable liquid, usually water.
Wet scrubber	Wet scrubbing entails separating the dust by intensively mixing the incoming gas with water, usually combined with the removal of the coarse particles through the use of centrifugal force. The removed dust is collected at the bottom of the scrubber. Also, substances such as SO_2, NH_3, some VOC and heavy metals may be removed

1.10.1.2. *NO_X emissions*

Technique	Description
Low-NO_X burner	Low-NO_X burners reduce the formation of NO_X by reducing peak flame temperatures, delaying but completing the combustion and increasing the heat transfer (increased emissivity of the flame). The ultra-low-NO_x burners includes combustion staging (air/fuel) and flue-gas recirculation
Oxy-fuel burner	The technique involves the replacement of the combustion air with oxygen, with the consequent elimination/reduction of thermal NO_X formation from nitrogen entering the furnace. The residual nitrogen content in the furnace depends on the purity of the oxygen supplied, on the quality of the fuel and on the potential air inlet
Flue-gas recirculation	This implies the reinjection of flue-gas from the furnace into the flame to reduce the oxygen content and therefore the temperature of the flame. The use of special burners is based on internal recirculation of combustion gases which cool the root of the flames and reduce the oxygen content in the hottest part of the flames

1.10.1.3. *SO_2, HCl, and HF emissions*

Technique	Description
Dry or semi-dry scrubber	Dry powder or a suspension/solution of an alkaline reagent (e.g. lime or sodium bicarbonate) is introduced and dispersed in the off-gas stream. The material reacts with the acidic gaseous species (e.g. SO_2) to form a solid which is removed by filtration (bag filter or electrostatic precipitator). The use of a reaction tower improves the removal efficiency of the scrubbing system. Adsorption can also be achieved by the use of packed towers (e.g. coke filter). For existing plants, the performance is linked to process parameters such as temperature (min. 60 °C), moisture content, contact time, gas fluctuations and to the capability of the dust filtration system (e.g. bag filter) to cope with the additional dust load
Wet scrubber	In the wet scrubbing process, gaseous compounds are dissolved in a scrubbing solution (e.g. an alkaline solution containing lime, NaOH, or H_2O_2). Downstream of the wet scrubber, the off-gases are saturated with water and a separation of the droplets is carried out before discharging the off-gases. The resulting liquid is further treated by a waste water process and the insoluble matter is collected by sedimentation or filtration. For existing plants, this technique may require significant space availability
Use of low-sulphur fuels	The use of natural gas or low-sulphur fuel oil reduces the amount of SO_2 and SO_3 emissions from the oxidation of sulphur contained in the fuel during combustion
Polyether-based absorption/desorption system	A polyether-based solvent is used to selectively absorb the SO_2 from the exhaust gases. Then the absorbed SO_2 is stripped in another column and the solvent is fully regenerated. The stripped SO_2 is used to produce liquid SO_2 or sulphuric acid

1.10.1.4. *Mercury emissions*

Technique	Description
Activated carbon adsorption	This process is based on the adsorption of mercury onto the activated carbon. When the surface has adsorbed as much as it can, the adsorbed content is desorbed as part of the regeneration of the adsorbent

Selenium adsorption	This process is based on the use of selenium-coated spheres in a packed bed. The red amorphous selenium reacts with the mercury in the gas to form HgSe. The filter is then treated to regenerate the selenium.

1.10.1.5. *VOC, PAH, and PCDD/F emissions*

Technique	Description
Afterburner or thermal oxidiser	Combustion system in which the pollutant within the exhaust gas stream reacts with oxygen in a temperature-controlled environment to create an oxidation reaction
Regenerative thermal oxidiser	Combustion system that employs a regenerative process to utilise the thermal energy in the gas and carbon compounds by using refractory support beds. A manifold system is needed to change the direction of the gas flow to clean the bed. It is also known as a regenerative afterburner
Catalytic thermal oxidiser	Combustion system where the decomposition is carried out on a metal catalyst surface at lower temperatures, typically from 350 °C to 400 °C. It is also known as a catalytic afterburner
Biofilter	It consists of a bed of organic or inert material, where pollutants from off-gas streams are biologically oxidised by microorganisms
Bioscrubber	It combines wet gas scrubbing (absorption) and biodegradation, the scrubbing water containing a population of microorganisms suitable to oxidise the noxious gas components
Select and feed the raw materials according to the furnace and the abatement techniques used	The raw materials are selected in such a way that the furnace and the abatement system used to achieve the required abatement performance can treat the contaminants contained in the feed properly
Optimise combustion conditions to reduce the emissions of organic compounds	Good mixing of air or oxygen and carbon content, control of the temperature of the gases and residence time at high temperatures to oxidise the organic carbon comprising PCDD/F. It can also include the use of enriched air or pure oxygen

Use charging systems, for a semi-closed furnace, to give small additions of raw material	Add raw material in small portions in semi-closed furnaces to reduce the furnace cooling effect during charging. This maintains a higher gas temperature and prevents the reformation of PCDD/F
Internal burner system	The exhaust gas is directed through the burner flame and the organic carbon is converted with oxygen to CO_2
Avoid exhaust systems with a high dust build-up for temperatures > 250 °C	The presence of dust at temperatures above 250 °C promotes the formation of PCDD/F by *de novo* synthesis
Injection of adsorption agent in combination with efficient dust collection system	PCDD/F may be adsorbed onto dust and hence emissions can be reduced using an efficient dust filtration system. The use of a specific adsorption agent promotes this process and reduces the emissions of PCDD/F
Rapid quenching	PCDD/F *de novo* synthesis is prevented by rapid gas cooling from 400 °C to 200 °C

1.10.2. **Water emissions**

Techniques	**Descriptions**
Chemical precipitation	The conversion of dissolved pollutants into an insoluble compound by adding chemical precipitants. The solid precipitates formed are subsequently separated by sedimentation, flotation or filtration. If necessary, this may be followed by ultrafiltration or reverse osmosis. Typical chemicals used for metal precipitation are lime, sodium hydroxide, and sodium sulphide.
Sedimentation	The separation of suspended particles and suspended material by gravitational settling
Flotation	The separation of solid or liquid particles from waste water by attaching them to fine gas bubbles, usually air. The buoyant particles accumulate at the water surface and are collected with skimmers
Filtration	The separation of solids from waste water by passing them through a porous medium. Sand is the most commonly used filtering medium
Ultrafiltration	A filtration process in which membranes with pore sizes of approximately 10 µm are used as the filtering medium

Activated carbon filtration	A filtration process in which activated carbon is used as the filtering medium
Reverse osmosis	A membrane process in which a pressure difference applied between the compartments separated by the membrane causes water to flow from the more concentrated solution to the less concentrated one

1.10.3. **Other**

Techniques	Descriptions
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
Centrifugal system	Centrifugal systems use inertia to remove droplets from off-gas streams by imparting centrifugal forces
Boosted suction system	Systems designed to modify the extraction fan capacity based on the sources of the fumes which change over the charging, melting and tapping cycles. Automated control of the burner rate during charging is also applied to ensure a minimum gas flow during operations with the door opened
Centrifugation of swarf	Centrifugation is a mechanical method to separate the oil from the swarf. To increase the velocity of the sedimentation process, a centrifugation force is applied to the swarf and the oil is separated
Drying of swarf	The swarf drying process uses an indirectly heated rotary drum. To remove the oil, a pyrolytic process takes place at a temperature between 300 °C and 400 °C
Sealed furnace door or furnace door sealing	The furnace door is designed to provide efficient sealing to prevent diffuse emissions escaping and to maintain the positive pressure inside the furnace during the smelting/melting stage

(**1**) OJ L 334, 17.12.2010, p. 17.

(**2**) OJ C 146, 17.5.2011, p. 3.

(**3**) The monitoring frequency may be adapted if the data series clearly demonstrate sufficient stability of the emissions.

(**4**) Description of the techniques are given in Section 1.10.

Changes to legislation:
There are outstanding changes not yet made to Commission Implementing Decision (EU) 2016/1032. Any changes that have already been made to the legislation appear in the content and are referenced with annotations.
View outstanding changes

Changes and effects yet to be applied to :

– Art. 2 substituted by S.I. 2018/1407 reg. 18(2)