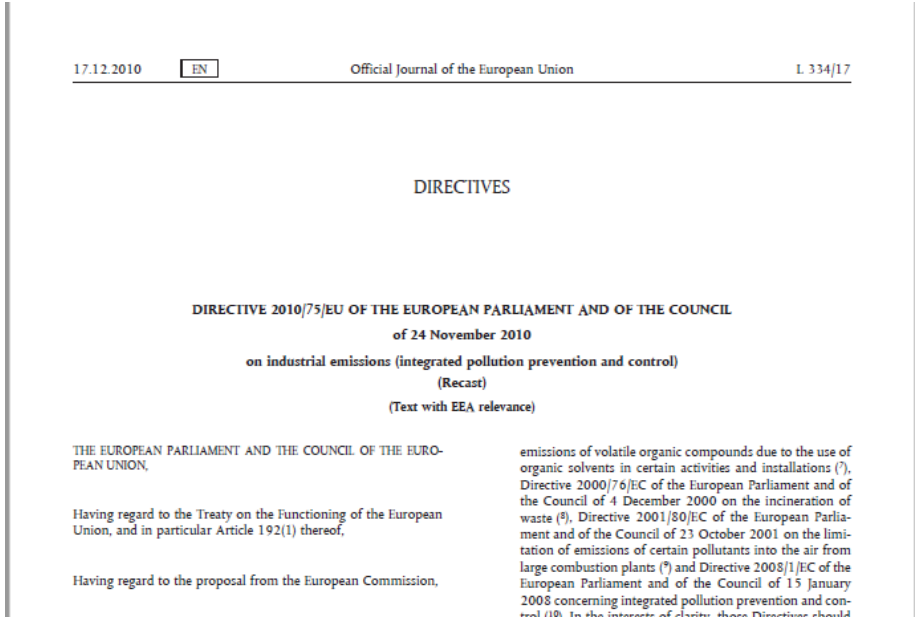
APPLICATION OF BAT/BEP IN THE NON-FERROUS METALS INDUSTRIES

REGULATIONS AND EXPERIENCES IN EU MEMBER STATES

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

INDUSTRIAL EMISSIONS DIRECTIVE (IED, 2010/75/EU)

- main EU instrument regulating pollutant emissions from industrial installations
- IED is based on several pillars
  - integrated approach
  - use of BAT
  - flexibility
  - inspections
  - public participation
- https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075



17.12.2010 EN Official Journal of the European Union L 334/17

DIRECTIVES

DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 24 November 2010
on industrial emissions (integrated pollution prevention and control)
(Recast)
(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 192(1) thereof,

Having regard to the proposal from the European Commission,

emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations (7), Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste (8), Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants (9) and Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control (10). In the interests of clarity, these Directives should

SEVILLA PROCESS

- BAT (best available techniques) and BAT-AEL (with BAT associated emission levels) are defined in the so called „Sevilla process“
- European Commission organises an exchange of information with experts from Member States, industry and environmental NGO
- Data-based process
- Result: BAT reference documents (BREFs) with BAT conclusions (BATc)
- https://eippcb.jrc.ec.europa.eu/reference

BREFs AND BAT CONCLUSIONS

- IED Art 14 (3): BAT conclusions are the **reference for setting permit conditions** → permit conditions must be based on BAT
- IED Art. 15 (3): **BAT-AELs** are the **binding requirements for pollutants** → the upper BAT-AEL level is the boundary for the emission limit value set in permits
- Art. 21(3): competent authorities must update installation permits to be in line with the content of the BAT conclusions AND operators must be compliant with them within 4 years of publication in the Official Journal of the EU

BREF NON FERROUS METALS INDUSTRIES (BREF NFM)

https://eippcb.jrc.ec.europa.eu/sites/default/files/2020-01/JRC107041_NFM_bref2017.pdf

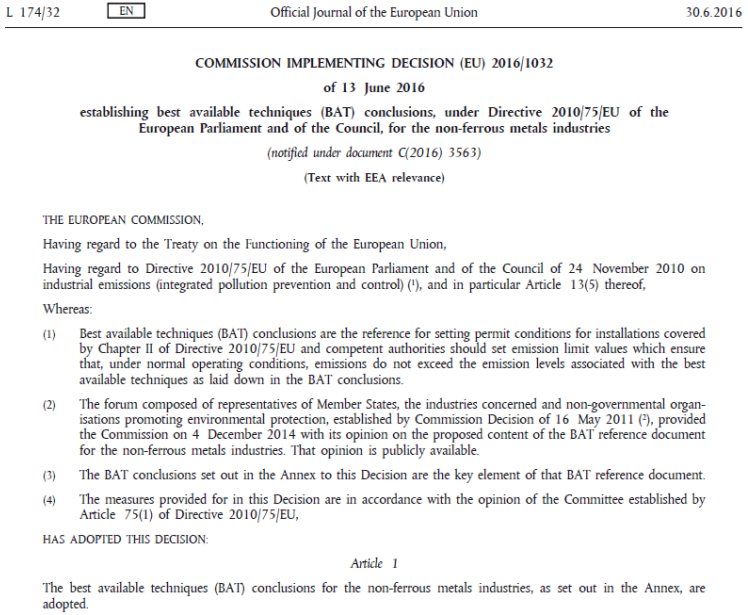
- more than 1000 pages
- Covering different non ferrous metals
- Information on
  - applied processes and techniques
  - current emission and consumption levels
  - techniques to consider in the determination of BAT
  - Best available techniques

BAT CONCLUSIONS (BATc) NFM

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2016.174.01.0032.01.ENG

published: 30.06.2016

to be implemented until 30.06.2020



L 174/32 EN Official Journal of the European Union 30.6.2016

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.

BATc NFM 2016

BAT CONCLUSIONS (BATc) NFM

- Covering all non ferrous metals
- General BAT conclusions
- BAT conclusions for specific metals and metalgroups
  - **Copper production**
  - **Aluminium production**
  - Lead and/or tin production
  - Zinc and/or cadmium production
  - Precious metals production
  - Ferro alloy-alloys production
  - Nickel and/or cobalt production
  - Carbon and/or graphite production

BATc SECONDARY ALUMINIUM PRODUCTION

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

BATc NFM 2016

BATc SECONDARY ALUMINIUM PRODUCTION

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)

BATc AL: SWARF DRYING

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 [1].

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.

BATc NFM 2016

BATc AL: DUST EMISSIONS

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 for dust from remelting in secondary aluminium production

Parameter	BAT-AEL (mg/Nm^3) (1) (2)
Dust	2-5

(1) As an average over the sampling period.
(2) 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.

BATc NFM 2016

BATc AL: REDUCTION OF PCDD/F AND ORGANIC CARBON

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 (1)
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

(1) Descriptions of the techniques are given in Section 1.10.

BATc AL: BAT-AEL PCDD/F AND ORGANIC CARBON

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 (1)
PCDD/F	ng I-TEQ/Nm^3	≤ 0,1 (2)

(1) As a daily average or as an average over the sampling period.
(2) As an average over a sampling period of at least six hours.

EXPERIENCES IN EU MEMBER STATES

Examples in Secondary Aluminium production

(BREF NFM 2017)

OIL AND ORGANIC COMPOUNDS REMOVAL FROM SWARF BEFORE THE MELTING STAGE

Centrifugation for highly contaminated swarf

Drying using a rotary dryer

Followed by afterburner/afterburning system

Lime/$NaHCO_3$ injection

(sometimes) carbon injection

PCDD/F emissions reported: 0.002 – 0.15 ng/Nm^3

Example plants: Germany, Italy and Austria

Generally applicable, unless furnace and abatement system are specifically designed to accommodate the organic content

SELECTION OF APPROPRIATE SECONDARY MELTING FURNACES

depends on type of input material, its size, oxide content and degree of contamination

Reverberatory furnaces (hearth, chamber, Closed Well or Side Well)

Requires no salt, for organically contaminated scrap with low oxide content

Rotary drum furnaces (fixed axis or tilting furnaces)

for scraps with higher oxide content.

This furnace type requires salt; use of tilting furnace requires less salt and results in less salt slag/salt cake

Induction furnaces

for rather clean scraps or process turnings, mostly used in foundries

Shaft furnaces

for melting of ingots and foundry returns

Parameter ([1])	Unit	Rotary drum furnace	Tilting rotary furnace	Closed well or Hearth furnace			Shaft furnace	Crucible furnace	Channel induction furnace
				Single chamber		Multiple-chamber, hearth furnace with melting bridge			
Preferred application		Production of secondary aluminium	Production of secondary aluminium	Production of secondary aluminium, foundries		Production of secondary aluminium	Moulding shops	Moulding shops	Production of secondary aluminium
Purpose		Melting	Melting	Melting	Holding, casting	Melting	Melting, holding	Melting, holding	Melting, holding
Preferred feedstock		New scrap (thin-walled, in small pieces), old scrap, dross	Old scrap, dross	Ingots, new/old scrap	Molten metal	Thin-walled new/old scrap (painted/coated)	Ingots, new scrap (recycled material)	Ingots, new scrap	Ingots, new/old scrap
Preferred melt treatment		Salt cover	Reduced salt cover compared to rotary drum	No salt cover, chlorination		No salt cover	No salt cover	No salt cover	No salt cover, chlorination
Capacity	t	Up to 150	Up to 30	Up to 180		Up to 180	0.5–4 (possibly up to 15)	0.1–0.6 ([6]), 0.5–6 ([c]), 0.1–1.2 ([d])	Approximately 50
Melting efficiency	t feedstock/h	Up to 20	Up to 7	Up to 30	NA	3–28	Up to 2.5 (typically 1.5)	0.075–0.26 ([b]), 0.25–3 ([c]), 0.1–0.43 ([d])	Approximately 7 (melting efficiency)
Preferred fuels		Natural gas, LPG, light fuel oil, medium/heavy fuel oil	Natural gas, LPG, extra-light fuel oil	Natural gas, LPG, extra-light fuel oil		Natural gas, LPG, extra-light fuel oil	Natural gas, LPG, extra-light fuel oil	Natural gas, LPG, extra-light fuel oil or electrically heated	Electrically heated
Energy use ([3])	GJ/t metal	2–4.7	2–2.5	2.5–4.4	No details	2.4–4.3	2.1–3.3 (depending on the mode of operation)	5.1–7.4 (M), ([b]), 1.7–3.5 (H), ([c]), 2.7/1.9–2.1 (M), ([b])/([c]), 0.4/0.9–1.2 (H), ([b])/([c])	Approximately 3.6 (M/H)
Waste gas rate ([5])	m^3/t metal	9000–18 000	9000–13 000	5000–13 000	No details	10 000–15 000	2000–4000	2000–4000 (M), ([b])	Max. 14 500
Dust generation		+++	+++	++	+	++	NR	NR	+
Nitrogen oxides ([3])		+ (assuming optimised combustion conditions) or ++ (for fuel-/oxygen-heated furnaces)						NR	NR
Sulphur dioxides ([3])		NR							
Chlorine ([4])		++ (chlorination)							
Hydrogen chloride ([4])		+++	++	+, ++ (chlorination)	+, ++ (chlorination)	++	NR	++ (chlorination)	++ (chlorination)
Hydrogen fluoride		+++	++	+	+	+	NR	++	+
Total organic carbon ([5])		++	++	+	+	+	NR	NR	NR
PCDD/F ([4])		+++	++	++	NR	+	NR	NR	NR

BREF NFM 2017, Table 4.28

PCDD/F EMISSIONS IN SECONDARY ALUMINIUM PLANTS IN EU

Abatement techniques

- activated carbon injection
- afterburner
- internal burner system

PCDD/F:
Average based on 6-hour sampling measurement:
Range: < 0.01–0.44 ng I-TEQ/Nm^3;
Data distribution: < 0.1 ng I-TEQ/Nm^3: 86.5 %; 0.1–0.2 ng I-TEQ/Nm^3: 5.4 %; 0.2–0.44 ng I-TEQ/Nm^3: 8.1 %.

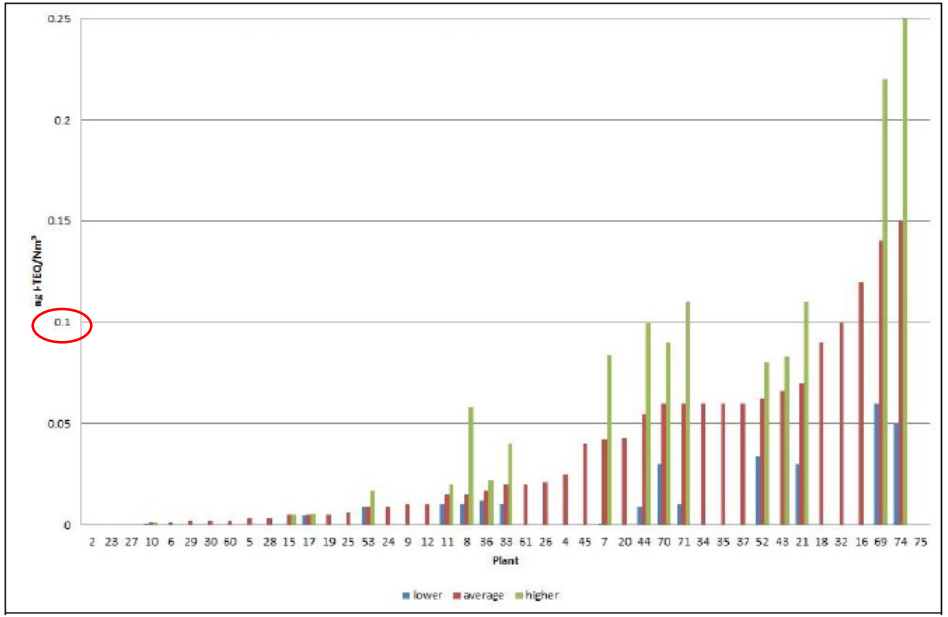


Figure 4.18: PCDD/F emissions in secondary aluminium production plants

BREF NFM 2017

EXAMPLES OF ABATEMENT COMBINATIONS IN EU IN SECONDARY ALUMINIUM PLANTS

- Closed Well Furnace (2 chambers) – injection of sorbalit (lime and activated carbon) – fabric filter
- Tilting rotary furnace – injection of NaHCO3 and activated carbon – fabric filter
- Tilting rotary furnace – (afterburner) – injection of additive – fabric filter

SECONDARY COPPER PRODUCTION

- Input materials are copper scrap, sludge, filter dust, slags computer and electronic scrap
- Input material with various copper content, other metals and organic materials
- Electronic scrap with brominated flame retardants as input material may result in the formation of mixed halogenated dioxins
- Processes are pre-treatment, smelting, converting, fire-refining, anode casting and electrolytic refining

BATc Cu: SEPARATION OF NON-METALLIC CONSTITUENTS

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)

BATc Cu: BAT-AEL FOR DUST EMISSIONS

Parameter	BAT	Process	BAT-AEL (mg/Nm^3)
	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 (2) (4)
	BAT 41	Secondary copper holding furnace	≤ 5 (1)
	BAT 42	Copper-rich slag furnace processing	2-5 (1) (6)
	BAT 43	Anode furnace (in primary and secondary copper production)	2-5 (2) (4)
	BAT 44	Anode casting (in primary and secondary copper production)	≤ 5-15 (2) (7)
	BAT 45	Copper melting furnace	2-5 (2) (8)

(1) As an average over the sampling period.
(2) As a daily average or as an average over the sampling period.
(3) As a daily average.
(4) 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.
(5) 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.
(6) Dust emissions are expected to be towards the lower end of the range when emissions of lead are above 1 mg/Nm^3.
(7) The lower end of the range is associated with the use of a bag filter.
(8) Dust emissions are expected to be towards the lower end of the range when emissions of copper are above 1 mg/Nm^3.

BATc NFM 2016

BATc Cu: REDUCTION OF PCDD/F EMISSIONS

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
f	Internal burner system
g	Post-combustion chamber or afterburner or regenerative thermal oxidiser (1)
h	Avoid exhaust systems with a high dust build-up for temperatures > 250 °C
i	Rapid quenching (1)
j	Injection of adsorption agent in combination with an efficient dust collection system (1)

(1) Descriptions of the techniques are given in Section 1.10.

BATc Cu – BAT-AEL FOR PCDD/F EMISSIONS

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) (1)
PCDD/F	≤ 0,1

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

EXPERIENCES IN EU MEMBER STATES

Examples in Secondary Copper production

(BREF NFM 2017)

FURNACES APPLIED DEPENDING ON INPUT MATERIALS

Broad variety of secondary materials are used with various copper content and broad concentration of other metals as well as electronic scrap

- ISASMELT furnace: for *smelting and converting* (dust, dross, slags,…)
- KRS (Kayser Recycling system): for *smelting and converting* (copper alloy scrap, electronic scrap, dross, dust, slags,…)
- Electric furnace: for smelting (wide range of copper materials, dust, dross, slags,…)
- Mini smelter and blast furnace: for smelting (scrap that contains iron and tin)
- TBRC (top blown rotary furnace): for smelting
- Contimelt: for melting (high grade copper scrap)

REDUCTION OF PCDD/F IN EU MS INSTALLATIONS

Problem: copper acts as catalyst in dioxin formation → secondary raw materials with even low organics and chlorine content may result in high PCDD/F quantities

- Aurubis Olen: lime and active coal system installed before bag filter
- Boliden Rönnskär: lime and activated carbon injection followed by bag filter
- Umicore Hoboken: dioxins destroyed in ISASMELT furnace or in the post-combustion
- Montanwerke Brixlegg: regenerative thermal oxidiser
- Metallo-Chimique Beerse: adsorption filter with sorbalite injection (combination of lime with activated coal)

BATc SECONDARY LEAD AND TIN PRODUCTION

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 (1)
b	Use charging systems, for a semi-closed furnace, to give small additions of raw material (1)
c	Internal burner system (1) for melting furnaces
d	Afterburner or regenerative thermal oxidiser (1)
e	Avoid exhaust systems with a high dust build-up at temperatures > 250 °C (1)
f	Rapid quenching (1)
g	Injection of adsorption agent in combination with efficient dust collection system (1)
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 (1)

(1) Descriptions of the techniques are given in Section 1.10.

BATc NFM 2016

BATc SECONDARY LEAD AND TIN PRODUCTION

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) (1)
PCDD/F	≤ 0,1

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

BATc NFM 2016

BATc SECONDARY ZINC PRODUCTION

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 (1)	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

(1) Descriptions of the techniques are given in Section 1.10.

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 (1)
PCDD/F	ng I-TEQ/Nm^3	≤ 0,1 (2)

(1) As a daily average or as an average over the sampling period.
(2) As an average over a sampling period of at least six hours.

BATc PRECIOUS METALS PRODUCTION

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 (1)
b	Injection of adsorption agent in combination with an efficient dust collection system (1)
c	Optimise combustion or process conditions for the abatement of emissions of organic compounds (1)
d	Avoid exhaust systems with a high dust build-up for temperatures > 250 °C (1)
e	Rapid quenching (1)
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 (1)

(1) Descriptions of the techniques are given in Section 1.10.

BATc PRECIOUS METALS PRODUCTION

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) (1)
PCDD/F	≤ 0,1

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

BATc FERRO-ALLOYS PRODUCTION

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 (1)

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

CONCLUSIONS

- PCDD/F ≤ 0.1 ng/Nm^3 is mandatory for all EU27 Member States in NFM production
- PCCD/F has to be monitored at least once a year
- BAT is a combination of the following techniques
  - Selection of input material according to furnace and abatement technique
  - Separation of non-metallic constituents and other metals before smelting stage
  - Internal burner systems
  - Afterburner or Regenerative Thermal Oxidiser (RTO)
  - Injection of activated carbon in combination with fabric filter
  - Optimisation of combustion conditions

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