JRC SCIENCE FOR POLICY REPORT

Best Available Techniques (BAT) Reference Document on Waste Incineration

Colour code used:

Black - adopted BREF (2006)

~~Strikethrough – deleted text from the adopted BREF (2006)~~

Green – new text in Draft 1

Blue highlights – explanatory notes to the TWG (e.g. on sections moved) or requests for additional inputs from the TWG

Yellow highlights – new references in Draft 1

Industrial Emissions Directive 2010/75/EU
(Integrated Pollution Prevention and Control)

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This document is one from the series of foreseen documents listed below (at the time of writing, not all documents have been drafted):

Reference Document on Best Available Techniques (BREF)	**Code**
Ceramic Manufacturing Industry	CER
Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector	CWW
Common Waste Gas Treatment in the Chemical Sector	WGC
Emissions from Storage	EFS
Energy Efficiency	ENE
Ferrous Metals Processing Industry	FMP
Food, Drink and Milk Industries	FDM
Industrial Cooling Systems	*ICS*
Intensive Rearing of Poultry and Pigs	IRPP
Iron and Steel Production	IS
Large Combustion Plants	LCP
Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilisers Industries	LVIC-AAF
Large Volume Inorganic Chemicals – Solids and Others Industry	LVIC-S
Large Volume Organic Chemical Industry	LVOC
Management of Tailings and Waste-rock in Mining Activities	MTWR
Manufacture of Glass	GLS
Manufacture of Organic Fine Chemicals	OFC
Non-ferrous Metals Industries	NFM
Production of Cement, Lime and Magnesium Oxide	CLM
Production of Chlor-alkali	CAK
Production of Polymers	POL
Pulp and Paper Industry	PP
Production of Speciality Inorganic Chemicals	SIC
Refining of Mineral Oil and Gas	REF
Slaughterhouses and Animals By-products Industries	SA
Smitheries and Foundries Industry	SF
Surface Treatment of Metals and Plastics	STM
Surface Treatment Using Organic Solvents including Wood and Wood Products Preservation with Chemicals	STS
Tanning of Hides and Skins	TAN
Textiles Industry	TXT
Waste Incineration	*WI*
Waste Treatment	WT
~~Wood and Wood Products Preservation with Chemicals~~	~~WPC~~
Wood-based Panels Production	WBP
Reference Document (REF)	
Economics and Cross-media Effects	ECM
~~General Principles of Monitoring~~ Monitoring of emissions to Air and Water from IED installations	~~MON~~ ROM

Electronic versions of draft and finalised documents are publicly available and can be downloaded from http://eippcb.jrc.ec.europa.eu

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5 BEST AVAILABLE TECHNIQUES (BAT) CONCLUSIONS

Scope

These BAT conclusions concern the following activities specified in Annex I to Directive 2010/75/EU:

5.2 Disposal or recovery of waste in waste incineration plants:
- (a) for non-hazardous waste with a capacity exceeding 3 tonnes per hour;
- (b) for hazardous waste with a capacity exceeding 10 tonnes per day.

5.2 Disposal or recovery of waste in waste co-incineration plants:
- (a) for non-hazardous waste with a capacity exceeding 3 tonnes per hour;
- (b) for hazardous waste with a capacity exceeding 10 tonnes per day;

whose main purpose is not the production of material products and:
- which combust only waste, other than waste defined in Article 3(31)(b) of Directive 2010/75/EU; or
- where more than 40 % of the resulting heat release comes from hazardous waste; or
- which combust mixed municipal waste.

5.3 (a) Disposal of non-hazardous waste with a capacity exceeding 50 tonnes per day involving the treatment of slags and/or bottom ashes from the incineration of waste.

5.3 (b) Recovery, or a mix of recovery and disposal, of non-hazardous waste with a capacity exceeding 75 tonnes per day involving the treatment of slags and/or bottom ashes from the incineration of waste.

These BAT conclusions do not address the following:

- Pre-treatment of waste prior to incineration; this may be covered by the BAT conclusions for Waste Treatment (WT).
- Treatment of incineration fly ashes and other residues resulting from flue-gas cleaning (FGC). These may be covered by the BAT conclusions for Waste Treatment (WT).
- Incineration or co-incineration of exclusively gaseous waste.
- Treatment of waste in plants covered by Article 42(2) of Directive 2010/75/EU.

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

- Waste Treatment (WT);
- Economics and Cross-Media Effects (ECM);
- Emissions from Storage (EFS);
- Energy Efficiency (ENE);
- Industrial Cooling Systems (ICS);
- Monitoring of Emissions to Air and Water from IED installations (ROM);
- Large Combustion Plants (LCP).

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Definitions

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

Term	Definition
	General terms
Bottom ash treatment plant	Plant treating slags and/or bottom ashes from the incineration of waste in order to separate and recover the valuable fraction and to allow the beneficial use of the remaining fraction
Clinical waste	Infectious or otherwise hazardous waste arising from healthcare institutions (e.g. hospitals)
Existing plant	A plant that is not a new plant
Fly ash	Particles from the incineration chamber or formed within the flue-gas stream that are transported in the flue-gas
Gross electrical efficiency	Ratio between the gross electrical output of the turbine and the waste/fuel energy input expressed as the lower heating value
Gross heat efficiency	Ratio between the gross heat output and the waste/fuel energy input. The energy input is expressed as the lower heating value; the gross heat output is expressed as the sum of: • the generated electricity output of the turbine • for direct export of steam and/or hot water, the exported thermal power less the thermal power of the return flow • the thermal power to primary heat exchangers
Hazardous waste	Hazardous waste as defined in Article 3(2) of Directive 2008/98/EC
Incineration plant	Either a waste incineration plant as defined in Article 3(40) of Directive 2010/75/EU, or a waste co-incineration plant as defined in Article 3(41) of Directive 2010/75/EU, covered by the scope of these BAT conclusions
Major plant upgrade	A major change in the design or technology of a plant with major adjustments or replacements of the process and/or abatement technique(s) and associated equipment
Municipal solid waste	Solid waste from households (mixed or separately collected) as well as solid waste from other sources that is comparable to household waste in nature and composition
New plant	A plant first permitted following the publication of these BAT conclusions or a complete replacement of a plant on the existing foundations following the publication of these BAT conclusions
Other non-hazardous waste	Non-hazardous waste that is neither municipal solid waste nor sewage sludge
Residues	Substances or objects generated by the activities covered by the scope of this document, as waste or by-products
Sewage sludge	Residual sludge from the storage, handling and treatment of domestic, urban or industrial waste water, except if this residual sludge constitutes hazardous waste
Slags and/or bottom ashes	Solid residues removed from the furnace once wastes have been incinerated

Term	Definition
	Pollutants and parameters
As	The sum of arsenic and its compounds, expressed as As
Cd	The sum of cadmium and its compounds, expressed as Cd
Cd+Tl	The sum of cadmium, thallium and their compounds, expressed as Cd+Tl
CO	Carbon monoxide
Cr	The sum of chromium and its compounds, expressed as Cr
Cu	The sum of copper and its compounds, expressed as Cu
Dust	Total particulate matter (in air)
HCl	All inorganic gaseous chlorine compounds, expressed as HCl
HF	All inorganic gaseous fluorine compounds, expressed as HF
Hg	The sum of mercury and its compounds, expressed as Hg
N_2O	Dinitrogen monoxide (nitrous oxide)
NH_3	Ammonia
NH_4-N	Ammonium nitrogen, expressed as N, includes free ammonia (NH_3) and ammonium ($NH4^+$)
Ni	The sum of nickel and its compounds, expressed as Ni
NO_X	The sum of nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2
PAHs	Polycyclic aromatic hydrocarbons
Pb	The sum of lead and its compounds, expressed as Pb
PCBs	Polychlorinated biphenyls
PCDD/F	Polychlorinated dibenzo-*p*-dioxins and -furans
POPs	Persistent Organic Pollutants as defined in Regulation (EC) No 850/2004 of the European Parliament and of the Council and amended by Commission Regulation (EU) No 756/2010
Sb+As+Pb+Cr+Co+ Cu+Mn+Ni+V	The sum of antimony, arsenic, lead, chromium, cobalt, copper, manganese, nickel, vanadium and their compounds, expressed as Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V
SO_2	Sulphur dioxide
SO_4^{2-}	Dissolved sulphate, expressed as SO_4^{2-}
TOC	Total organic carbon, expressed as C (in water)
TSS	Total suspended solids. Mass concentration of all suspended solids (in water), measured via filtration through glass fibre filters and gravimetry
Tl	The sum of thallium and its compounds, expressed as Tl
TVOC	Total volatile organic carbon, expressed as C (in air)
Zn	The sum of zinc and its compounds, expressed as Zn

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Acronyms

For the purposes of these BAT conclusions, the following **acronyms** apply:

Acronym	Definition
EMS	Environmental management system
FGC	Flue-gas cleaning
OTNOC	Other than normal operating conditions
SCR	Selective catalytic reduction
SNCR	Selective non-catalytic reduction

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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, these BAT conclusions are generally applicable.

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

Emission levels associated with the best available techniques (BAT-AELs) for emissions to air given in these BAT conclusions refer to concentrations, expressed as mass of emitted substances per volume of flue-gas under the following standard conditions: dry gas at a temperature of 273.15 K and a pressure of 101.3 kPa, and expressed in the units mg/Nm^3, µg/Nm^3, ng I-TEQ/Nm^3 or ng WHO-TEQ/Nm^3.

The reference oxygen levels used to express BAT-AELs in this document are shown in the table below.

Activity	Reference oxygen level (OR)
Incineration	11 vol-%
Bottom ash treatment	No correction for the oxygen level

The equation for calculating the emission concentration at the reference oxygen level is:

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

Where:

- E_R: emission concentration at the reference oxygen level O_R;
- O_R: reference oxygen level in vol-%;
- E_M: measured emission concentration;
- O_M: measured oxygen level in vol-%.

For averaging periods, the following **definitions** apply:

Averaging period	Definition
Half-hourly average	Average value over a period of 30 minutes of continuous measurement
Daily average	Average over a period of 24 hours of valid half-hourly averages obtained by continuous measurement
Average over the sampling period	Average value of three consecutive measurements of at least 30 minutes each ([1])
Long-term sampling average	Average value over a sampling period of 2 to 4 weeks

([1]) For any parameter where, due to sampling or analytical limitations, a 30-minute measurement is inappropriate, a more suitable sampling period may be employed. For PCDD/F and dioxin-like PCBs, one sampling period of 6 to 8 hours is used in the case of short-term sampling.

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When waste is co-incinerated together with non-waste fuels, the BAT-AELs for emissions to air given in these BAT conclusions apply to the entire flue-gas volume generated.

Emission levels associated with the best available techniques (BAT-AELs) for emissions to water

Emission levels associated with the best available techniques (BAT-AELs) for emissions to water given in these BAT conclusions refer to concentrations (mass of emitted substances per volume of waste water), expressed in the units mg/l or ng I-TEQ/l. The BAT-AELs refer to daily averages, i.e. 24-hour flow-proportional composite samples. Time-proportional composite sampling can be used provided that sufficient flow stability is demonstrated.

The BAT-AELs for emissions to water apply at the point where the emission leaves the installation.

Energy efficiency levels associated with the best available techniques (BAT-AEELs)

An energy efficiency level associated with the best available techniques (BAT-AEEL) refers to the ratio between the plant's gross energy output(s) and the energy input into the thermal treatment unit(s), including waste and other fuels, at actual plant design and for the plant operated at full load.

BAT-AEELs are expressed as a percentage. The waste/fuel energy input is expressed as lower heating value.

Destruction efficiency

The equation for calculating the destruction efficiency (DE) of POPs contained in the waste is:

$$DE = 1 - \frac{POP_{slag} + POP_{fash} + POP_{water} + POP_{fgas}}{POP_{waste}}$$

Where:

- POP_{waste} is the mass of POPs in the waste prior to incineration;
- POP_{slag} is the mass of POPs remaining in the incineration slag/bottom ash;
- POP_{fash} is the mass of POPs ending up in the fly ashes and in dry FGC residues;
- POP_{water} is the mass of POPs ending up in the waste water from FGC and in the related waste water treatment sludge;
- POP_{fgas} is the mass of POPs emitted with the flue-gas.

Content of unburnt substances in bottom ashes/slags

The content of unburnt substances in the slags and/or bottom ashes can be expressed either as loss on ignition or as the TOC mass fraction as a percentage, on a dry basis.

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5.1 BAT conclusions

5.1.1 Environmental management systems

[To the TWG: the following description of the general EMS features is based on standard text agreed at the level of the IED Article 13 Forum and used in recent documents such as the BAT conclusions for CWW, IRPP, NFM, REF, etc. The possibilities for changes are therefore limited.]

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:

i. commitment of the management, including senior management;
ii. definition, by the management, of an environmental policy that includes the continuous improvement of the environmental performance of the installation;
iii. planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;
iv. implementation of procedures paying particular attention to:

    a. structure and responsibility;
    b. recruitment, training, awareness and competence;
    c. communication;
    d. employee involvement;
    e. documentation;
    f. effective process control;
    g. planned regular maintenance programmes;
    h. emergency preparedness and response;
    i. safeguarding compliance with environmental legislation;

v. checking performance and taking corrective action, paying particular attention to:

    a. monitoring and measurement (see also the JRC Reference Report on Monitoring of emissions to air and water from IED-installations – ROM);
    b. corrective and preventive action;
    c. maintenance of records;
    d. independent (where practicable) internal and external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;

vi. review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness;
vii. following the development of cleaner technologies;
viii. 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 including:

    a. avoiding unnecessary underground structures;
    b. incorporating features that facilitate dismantling;
    c. choosing surface finishes that are easily decontaminated;
    d. using an equipment configuration that minimises trapped chemicals and facilitates drainage or cleaning;
    e. designing flexible, self-contained equipment that enables phased closure;
    f. using biodegradable and recyclable materials where possible;

ix. application of sectoral benchmarking on a regular basis.

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Specifically for incineration plants and, where relevant, bottom ash treatment plants, BAT is to also incorporate the following features in the EMS:

x. waste stream management plan (see BAT 10 and BAT 11);
xi. residues management plan including measures aiming to:

   a. minimise the generation of residues;
   b. optimise the reuse, regeneration, recycling and/or energy recovery of the residues;
   c. ensure the proper disposal of residues;

xii. OTNOC management plan (see BAT 19);
xiii. accident management plan (see BAT 2);
xiv. odour management plan where odour nuisance at sensitive receptors is expected and/or has been substantiated, including:

   a. a protocol for conducting odour monitoring in accordance with EN standards (e.g. EN 13725); it may be complemented by measurement/estimation of odour exposure (e.g. according to EN 16841-1 or EN 16841-2) or estimation of odour impact;
   b. a protocol for response to identified odour incidents, e.g. complaints;
   c. an odour prevention and reduction programme designed to identify the source(s); to measure/estimate odour exposure, to characterise the contributions of the sources; and to implement prevention and/or reduction measures;

xv. noise management plan (see also BAT 36) where noise nuisance at sensitive receptors is expected and/or has been substantiated, including;

   a. a protocol for conducting noise monitoring;
   b. a protocol for response to identified noise and vibration incidents;
   c. a noise and vibration reduction programme designed to identify the source(s), to measure/estimate noise and vibration exposure, to characterise the contributions of the sources and to implement prevention and/or reduction measures.

Applicability
The scope (e.g. level of detail) and nature of the EMS (e.g. standardised or non-standardised) is generally related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have (determined also by the type and the amount of waste processed).

[This BAT conclusion is based on information given in Section 4.1.1]

BAT 2. In order to prevent the occurrence of accidents and to reduce the environmental consequences when accidents occur, BAT is to set up and implement an accident management plan (see BAT 1).

Description
An accident management plan is part of the EMS (see BAT 1) and identifies hazards posed by the installation and the associated risks and defines measures to address these risks. It considers the inventory of pollutants present or likely to be present which could have environmental consequences if they escape.

The accident management plan includes the setting up and implementation of a fire prevention, detection and control plan, which is risk-based and includes the use of automatic fire detection and warning systems, and of manual and/or automatic fire intervention and control systems. The fire prevention, detection and control plan is relevant in particular for:

- waste storage and pretreatment areas;
- furnace loading areas;
- electrical control systems;
- bag filters;
- fixed adsorption beds.

The accident management plan also includes, in particular in the case of installations where hazardous wastes are received, personnel training programmes regarding:

- explosion and fire prevention;
- fire extinguishing;
- knowledge of chemical risks (labelling, carcinogenic substances, toxicity, corrosion, fire) and transportation.

[This BAT conclusion is based on information given in Section 4.2.4.7]

5.1.2 Monitoring

BAT 3. BAT is to determine the gross electrical efficiency and/or the gross total heat efficiency of the incineration plant by carrying out a performance test at full load ([1]), according to EN standards, after the commissioning of the plant and after each modification that could significantly affect the gross electrical efficiency and/or the gross total heat efficiency of the plant. 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.

([1]) In the case of cogeneration plants, if all of the steam produced at full load is converted to electricity, the gross electrical efficiency is determined. If, for technical reasons, not all of the steam produced at full load can be converted to electricity, the gross total heat efficiency is determined instead.

BAT 4. BAT is to monitor key process parameters relevant for emissions to air and water including those given below.

Stream	Parameter(s)	Monitoring
Flue-gas from incineration	Flow, oxygen content, temperature, pressure, water vapour content ([1])	Continuous measurement
Waste water from flue-gas treatment	Flow, pH, temperature	
Waste water from bottom ash treatment	Flow, pH, conductivity	

([1]) The continuous measurement of the water vapour content of the flue-gas is not necessary if the sampled flue-gas is dried before analysis.

BAT 5. BAT is to monitor 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.

Substance/ Parameter	Process	Standard(s) (1)	Minimum monitoring frequency	Monitoring associated with
NO_X	Incineration	Generic EN standards	Continuous	BAT 29
NH_3	When SNCR and/or SCR is used	Generic EN standards	Continuous	BAT 29
N_2O	• Incineration in fluidised bed furnaces • When SNCR is operated with urea	EN 21258	Once every year	BAT 29
CO	Incineration	Generic EN standards	Continuous	BAT 29
SO_2	Incineration	Generic EN standards	Continuous	BAT 28
HCl	Incineration	Generic EN standards	Continuous	BAT 28
HF	Incineration	Generic EN standards	Continuous (2)	BAT 28
Dust	Bottom ash treatment	EN 13284-1	Once every year	BAT 27
	Incineration	Generic EN standards and EN 13284-2	Continuous	BAT 26
Metals and metalloids except mercury (As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Sb, Tl, V)	Incineration	EN 14385	Once every six months	BAT 26
Hg	Incineration	Generic EN standards and EN 14884	Continuous (3)	BAT 31
TVOC	Incineration	Generic EN standards	Continuous	BAT 30
PCDD/F	Incineration	No EN standard available for long-term sampling, EN 1948-2, EN 1948-3	Once every month (4)	BAT 30
Dioxin-like PCBs	Incineration	No EN standard available for long-term sampling, EN 1948-2, EN 1948-4	Once every month (5)(6)	BAT 30
Benzo[*a*]pyrene	Incineration	No EN standard available	Once every year	BAT 30

(1) Generic EN standards for continuous measurements are EN 15267-1, EN 15267-2, EN 15267-3, and EN 14181. EN standards for periodic measurements are given in the table or in the footnotes.
(2) The continuous measurement of HF may be replaced by periodic measurements with a minimum frequency of once every six months if the HCl emission levels are proven to be sufficiently stable. No EN standard is available for the periodic measurement of HF.
(3) For incineration plants with a capacity of < 100 000 tonnes/year incinerating exclusively non-hazardous waste, and for plants incinerating wastes with intrinsically low and constant mercury content (e.g. sewage sludge, mono-streams of waste of controlled composition), the continuous monitoring of emissions can be replaced by long-term sampling or periodic monitoring with a minimum frequency of once every six months. In the latter case the relevant standard is EN 13211.
(4) The monitoring frequency of once every month refers to monitoring carried out by long-term sampling. For incineration plants incinerating exclusively non-hazardous waste and for incineration plants where PCCD/F emission levels are proven to be sufficiently stable, the monthly long-term sampling of PCDD/F emissions can be replaced by periodic measurements with a minimum monitoring frequency of once every six months. In this case

the relevant standard for sampling is EN 1948-1.
([5]) The monitoring frequency of once every month refers to monitoring carried out by long-term sampling. For incineration plants burning exclusively non-hazardous waste and for incineration plants where PCB emission levels are proven to be sufficiently stable, the monthly long-term sampling of PCB emissions can be replaced by periodic measurements with a minimum monitoring frequency of once every six months. In this case the relevant standard for sampling is EN 1948-1.
([6]) Where emissions of dioxin-like PCBs are demonstrated to represent less than 20 % of the toxic equivalent of PCDD/F expressed as WHO-TEQ, the monitoring of PCBs does not apply.

BAT 6. BAT is to appropriately monitor emissions from the incineration plant during OTNOC.

Description

The monitoring can be carried out by direct emission measurements or by monitoring of surrogate parameters if this proves to be of equivalent or better scientific quality than direct emission measurements. Emissions during start-up and shutdown while no waste is being incinerated may be estimated based on at least one measurement campaign per year carried out during a planned start-up/shutdown operation.

BAT 7. BAT is to monitor emissions to water from FGC and/or bottom ash treatment 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.

Substance/Parameter	Process	Standard(s)	Minimum monitoring frequency	Monitoring associated with
Total organic carbon (TOC)	FGC Bottom ash treatment	EN 1484	Once every month	BAT 34
Total suspended solids (TSS)	FGC Bottom ash treatment	EN 872		
As	FGC	Various EN standards available (e.g. EN ISO 11885 or EN ISO 17294-2)		
Cd	FGC			
Cr	FGC			
Cu	FGC			
Mo	FGC			
Ni	FGC			
Pb	FGC Bottom ash treatment			
Sb	FGC			
Tl	FGC			
Zn	FGC			
Hg	FGC	Various EN standards available (e.g. EN ISO 12846 or EN ISO 17852)		
NH_4-N	Bottom ash treatment	Various EN standards available (i.e. EN ISO 11732, EN ISO 14911)		
Chloride (Cl^-)	Bottom ash treatment	Various EN standards (i.e. EN ISO 10304-1, EN ISO 15682)		
SO_4^{2-}	Bottom ash treatment	EN ISO 10304-1		
PCDD/F	FGC Bottom ash treatment	No EN standard available		

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BAT 8. BAT is to monitor the total organic carbon content of bottom ashes/slags and/or their loss on ignition in accordance with EN 13137 and/or EN 15169. The minimum monitoring frequency is once every three months.

BAT 9. For the incineration of hazardous waste containing POPs, BAT is to monitor the POP destruction efficiency at least once every year 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.

Description
The POP destruction efficiency is determined by analysing the POP content in:

- waste prior to incineration;
- incineration slags and bottom ashes;
- fly ashes and dry FGC residues;
- waste water from FGC and in the related waste water treatment sludge;
- flue-gas.

Applicability
Only applicable if the POP levels in the wastes prior to incineration exceed the concentration limits defined in Annex IV to Regulation (EC) No 850/2004 as amended by Commission Regulation (EU) No 756/2010.

To the TWG: please provide information to confirm the proposed BAT 9 based on established practices.

5.1.3 General environmental and combustion performance

BAT 10. In order to improve the overall environmental performance of the incineration plant, as part of the waste stream management plan (see BAT 1), BAT is to use all of the techniques (a) to (d) given below, and, where relevant, also techniques (e) and (f).

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	Technique	Description
a.	Determination of the types of waste that can be incinerated	Based on the characteristics of the incineration plant, identification of the types of waste which can be incinerated in terms of, for example, the physical state and the acceptable ranges of calorific value, humidity, ash content, size.
b.	Set-up and implementation of waste characterisation and pre-acceptance procedures	These procedures aim to ensure the technical (and legal) suitability of waste treatment operations for a particular waste prior to the arrival of the waste at the plant. They include procedures to collect information about the waste input and may include waste sampling and characterisation to achieve sufficient knowledge of the waste composition. Waste pre-acceptance procedures are risk-based considering, for example, the hazardous properties of the waste, the risks posed by the waste in terms of process safety, occupational safety and environmental impact, as well as the information provided by the previous waste holder(s).
c.	Set-up and implementation of waste acceptance procedures	Acceptance procedures aim to confirm the characteristics of the waste, as identified in the pre-acceptance stage. These procedures define the elements to be verified upon the delivery of the waste at the plant as well as the waste acceptance and rejection criteria. They may include waste sampling, inspection and analysis. Waste acceptance procedures are risk-based considering, for example, the hazardous properties of the waste, the risks posed by the waste in terms of process safety, occupational safety and environmental impact, as well as the information provided by the previous waste holder(s). The elements to be monitored for each type of waste are detailed in BAT 12.
d.	Set-up and implementation a waste tracking system and inventory	A waste tracking system and inventory aim to track the location and quantity of waste in the plant. It holds all the information generated during waste pre-acceptance procedures (e.g. date of arrival at the plant and unique reference number of the waste, information on the previous waste holder(s), pre-acceptance and acceptance analysis results, nature and quantity of waste held on site including all identified hazards), acceptance, storage, treatment and/or transfer off site. The waste tracking system is risk-based considering, for example, the hazardous properties of the waste, the risks posed by the waste in terms of process safety, occupational safety and environmental impact, as well as the information provided by the previous waste holder(s). The waste tracking system includes clear labelling of wastes that are stored in places other than the waste bunker or sludge storage tank (e.g. in containers, drums, bales or other forms of packaging) such that they can be identified at all times.
e.	Waste segregation	Wastes are kept separated depending on their properties in order to enable easier and environmentally safer storage and incineration. Waste segregation relies on the physical separation of different wastes and on procedures that identify when and where wastes are stored.
f.	Verification of waste compatibility prior to mixing or blending of waste	Compatibility is ensured by a set of verification measures and tests in order to detect any unwanted and/or potentially dangerous chemical reactions between wastes (e.g. polymerisation, gas evolution, exothermal reaction, decomposition) upon mixing or blending. The compatibility tests are risk-based considering, for example, the hazardous properties of the waste, the risks posed by the waste in terms of process safety, occupational safety and environmental impact, as well as the information provided by the previous waste holder(s).

BAT 11. In order to improve the overall environmental performance of the bottom ash treatment plant, as part of the waste stream management plan (see BAT 1), BAT is to set up and implement an output quality management system.

Description

Setting up and implementing an output quality management system, so as to ensure that the output of the bottom ash treatment is in line with expectations, using existing EN standards where available. This management system also allows the performance of the bottom ash treatment to be monitored and optimised.

BAT 12. In order to improve the overall environmental performance, BAT is to monitor the waste deliveries as part of the waste acceptance procedures (see BAT 10) including the elements given below.

Waste type	Monitoring
Municipal solid waste and other non-hazardous waste	• Radioactivity detection • Weighing of the waste deliveries • Visual inspection • Periodic sampling of individual deliveries and analysis of key properties/substances (e.g. calorific value, content of halogens and metals/metalloids). For municipal solid waste, this involves separate unloading
Sewage sludge	• Weighing of the waste deliveries • Visual inspection • Periodic sampling and analysis of key properties/substances (e.g. calorific value, water and ash content)
Hazardous waste	• Radioactivity detection • Weighing of the waste deliveries • Visual inspection • Unpacking and visual inspection of baled waste deliveries • Control and comparison of individual waste deliveries with the declaration of the waste producer • Sampling of the content of: o all bulk tankers o randomly selected drums/bales in drummed and other packaged waste deliveries and analysis of: o combustion parameters (including calorific value and flashpoint) o waste compatibility, to detect possible hazardous reactions upon blending or mixing wastes, prior to storage o key substances including PCBs, halogens and sulphur, metals/metalloids
Clinical waste	• Radioactivity detection • Weighing of the waste deliveries

[This BAT conclusion is based on information given in Sections 4.2.3.1, 4.2.3.2, 4.2.3.3, 4.2.3.4, 4.2.3.5]

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BAT 13. In order to reduce the environmental risks associated with the reception, handling and storage of waste, BAT is to use both of the techniques given below.

	Technique	Description
a.	Impermeable surfaces and segregated drainage	Depending on the risks posed by the waste in terms of soil or water contamination, the surface of the waste reception, handling and storage areas is concrete-based or made impermeable to the liquids concerned, and fitted with segregated drainage
b.	Adequate storage capacity	Measures are taken to avoid accumulation of waste, such as: • the maximum waste storage capacity is clearly established and not exceeded, taking into account the characteristics of the wastes (e.g. regarding the risk of fire) and the treatment capacity, • the quantity of waste stored is regularly monitored against the maximum allowed storage capacity; • the maximum residence time of waste is clearly established

[This BAT conclusion is based on information given in Sections 4.2.4.1, 4.2.4.2, 4.2.4.5]

BAT 14. In order to reduce the environmental risk associated with the storage and handling of clinical waste, BAT is to use technique (a) and either technique (b) or (c)-given below.

	Technique	Description
a.	Automated waste handling	The use of non-manual waste handling and loading systems
b.	Use of sealed, puncture-resistant containers	Clinical waste is delivered in sealed and robust, puncture-resistant combustible containers that are never opened throughout storage and handling operations
c.	Cleaning and disinfection of containers	Waste containers that are to be reused are cleaned in a designated cleaning area and disinfected in a facility specifically designed for disinfection. Any solid residues from the cleaning operations are incinerated

[This BAT conclusion is based on information given in Section 4.2.4.1]

BAT 15. In order to improve the overall environmental performance, to reduce the content of unburnt substances in slags and bottom ashes, and to reduce emissions to air from the incineration of waste, BAT is to use an appropriate combination of the techniques given below.

	Technique	Description	Applicability
a.	Waste blending and mixing	See Section 5.2.1	Not applicable to infectious clinical waste. Blending and mixing is not applicable where undesired reactions may occur between different types of waste.
b.	Advanced control system	See Section 5.2.1	Generally applicable
c.	Optimisation of the incineration process	See Section 5.2.1	Optimisation of the design of the incineration chamber is not applicable to existing furnaces

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BAT-associated environmental performance levels
The TOC content in slags and bottom ashes associated with BAT is 1–3 wt-%.
The loss on ignition of slags and bottom ashes associated with BAT is 1–5 wt-%.

The associated monitoring is in BAT 8.

[This BAT conclusion is based on information given in Sections 4.2.5.1, 4.3.6, 4.3.9, 4.3.1, 4.3.24, 4.7.1]

BAT 16. In order to improve the overall environmental performance of the incineration plant and to reduce emissions to air, BAT is to set up and implement procedures for the adjustment of the plant's settings, e.g. though the advanced control system (see description in Section 5.2.1), as and when needed and practicable, based on the characterisation and control of the input waste (see BAT 12).

BAT 17. In order to improve the overall environmental performance of the incineration plant, BAT is to set up and implement operational procedures (e.g. organisation of the supply chain, continuous rather than batch operation, preventive maintenance) to limit as far as practicable shutdown and start-up operations.

[This BAT conclusion is based on information given in Section 4.1.2]

BAT 18. In order to reduce emissions to air and water, BAT is to ensure, by appropriate design, operation and maintenance, that the flue-gas cleaning system and the waste water treatment plant are used at optimal capacity and availability.

BAT 19. In order to reduce the frequency of the occurrence of OTNOC and to reduce emissions to air and/or to water from the incineration plant during OTNOC, BAT is to set up and implement a risk-based OTNOC management plan as part of the environmental management system (see BAT 1) that includes all of the following elements:

- identification of potential OTNOC, of their root causes (e.g. failure of emission abatement systems, including identification of equipment critical to the protection of the environment ('critical equipment')) and of their potential consequences, and regular review and update of the list of identified OTNOC following the periodic assessment below;
- appropriate design of critical equipment (e.g. compartmentalisation of the bag filter, supplementary burners to heat up the flue-gas and obviate the need to bypass the bag filter on start-up, etc.);
- set-up and implementation of a preventive maintenance plan for critical equipment;
- monitoring and recording of emissions during OTNOC and associated circumstances (see BAT 6);
- periodic assessment of the emissions occurring during OTNOC (e.g. frequency of events, duration, amount of pollutants emitted) and implementation of corrective actions if necessary.

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5.1.4 Energy efficiency

BAT 20. In order to increase resource efficiency and enable the recovery of energy from the incineration of waste, BAT is to use a heat recovery boiler.

Description

The energy contained in the flue-gas is recovered in a heat recovery boiler producing hot water and/or steam, which may be exported, used internally, and/or used to produce electricity.

Applicability

In the case of plants dedicated to the incineration of hazardous waste, the applicability may be limited by:

- the stickiness of the fly ashes;
- the corrosiveness of the flue-gas.

BAT 21. In order to increase the energy efficiency of the incineration plant, BAT is to use a combination of the techniques given below.

	Technique	Description	Applicability
a.	Thermal drying of sewage sludge	After mechanical dewatering, sewage sludge is further dried using low-grade heat prior to incineration	Applicable within the constraints associated with the availability of low-grade heat
b.	Reduction of the flue-gas flow	The flue-gas flow is reduced through, e.g.: • improving the primary and secondary air distribution; • recirculation of raw flue-gas (extracted before the FGC); see Section 5.2.2; • oxygen-enriched combustion air. A smaller flue-gas volume reduces the energy demand of the plant (e.g. for induced draft fans).	Generally applicable
c.	Minimisation of heat losses	Heat losses are minimised through: • thermal insulation of furnaces and boilers; • recovery of heat from the cooling of slags and bottom ashes	Generally applicable
d.	Optimisation of the boiler design	The heat transfer in the boiler is improved by optimising, for example, the: • flue-gas velocity and distribution; • water/steam circulation; • convection bundles; • cleaning devices for the convection bundles.	Applicable to new plants and to major retrofits of existing plants
e.	Low flue-gas temperature at boiler exit	Special corrosion-resistant heat exchangers are used to recover additional energy from the flue-gas, reducing its temperature at the boiler exit	Applicable within the constraints of the operating temperature of the downstream FGC system

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f.	High steam conditions	The higher the steam conditions (temperature and pressure), the higher the electricity conversion efficiency allowed by the steam cycle. Working at increased steam conditions (e.g. above 45 bar, 400 °C) requires the use of special steel alloy or refractory cladding to protect the boiler sections that are exposed to the highest temperatures.	Applicable to new plants and to major retrofits of existing plants, where the plant is mainly oriented towards the generation of electricity. The applicability may be limited by: • the stickiness of the fly ashes; • the corrosiveness of the flue-gas.
g.	Cogeneration	Cogeneration of heat and electricity where the heat (mainly from the steam system) is used for producing hot water/steam to be used in industrial processes/activities or in a public network for district heating/cooling	Applicable within the constraints associated with the local heat and power demand
h.	Flue-gas condenser	A heat exchanger where the water vapour contained in the flue-gas condenses, transferring the latent heat to water at a sufficiently low temperature (e.g. return flow of a district heating network). The flue-gas condenser also provides co-benefits by reducing emissions to air (e.g. of dust and acid gases). The use of heat pumps can increase the amount of energy recovered from flue-gas condensation	Applicability may be limited by the demand for low-temperature heat, e.g. by the availability of a district heating network with a sufficiently low return temperature

Table 5.1: BAT-associated energy efficiency levels (BAT-AEELs) for incineration

Type of waste incinerated	BAT-AEELs		
	Gross electrical efficiency (%) (1) (2)		Gross heat efficiency (%) (3)
	New plant	Existing plant	New or existing plant
Municipal solid waste and other non-hazardous waste	25–35	20–35	72–91(4)
Sewage sludge	15–24(5)	12–21	60–70 (5)
Hazardous waste (6)	16–32	14–32	65–89

(1) The BAT-AEELs for gross electrical efficiency apply to plants producing only electricity and to cogeneration plants mainly oriented towards the production of electricity.
(2) The higher end of the BAT-AEEL range can be achieved with high steam conditions (pressure, temperature).
(3) The BAT-AEELs for gross heat efficiency apply to plants producing only heat (steam and/or hot water) and to cogeneration plants mainly oriented towards the production of heat.
(4) A gross heat efficiency exceeding the higher end of the BAT-AEEL range (even above 100 %) can be achieved where a flue-gas condenser is used.
(5) For the incineration of sewage sludge, the gross electrical efficiency is highly dependent on the water content.
(6) The BAT-AEELs do not apply if a heat recovery boiler is not applicable.

The associated monitoring is in BAT 3.

[This BAT conclusion is based on information given in Sections 4.4.1, 4.4.2, 4.4.5, 4.4.8, 4.4.9, 4.4.11, 4.4.15, 4.4.16, 4.4.17, 4.4.19]

[Note to the TWG: Based on the performances of actual plants, the data collected do not allow the proposal of a BAT-AEEL range for electrical efficiency of new sewage sludge incineration plants and a lower end of the BAT-AEEL range for heat efficiency of sewage sludge incineration plants. The proposed values are based on expert judgement.]

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5.1.5 Emissions to air

5.1.5.1 Diffuse emissions

BAT 22. In order to prevent or reduce diffuse emissions, including odour emissions, from bulk waste storage areas including tanks and bunkers and from waste pretreatment areas, BAT is to enclose those areas, keep them under negative pressure, and use the extracted air as combustion air for incineration. When the incinerator is not available (e.g. during maintenance), BAT is to minimise the amount of waste in storage and/or to use an alternative abatement technique (e.g. a wet scrubber).

Description
Solid and pasty wastes are kept in enclosed buildings from which incineration air is drawn; liquid waste tank vents are ducted to the incineration air feed.

During shutdown periods the amount of waste in storage is minimised, e.g. by interrupting or reducing waste deliveries, as part of the waste stream management plan (see BAT 1).

[This BAT conclusion is based on information given in Section 4.2.4.4]

BAT 23. In order to prevent diffuse emissions of volatile compounds from the handling of gaseous and liquid wastes, BAT is to feed them into the furnace by direct injection.

Description
Direct injection is carried out by connecting the waste container to the furnace feeding line. The container is then emptied by pressurising it with nitrogen or, if the viscosity is low enough, by pumping the liquid.

[This BAT conclusion is based on information given in Section 4.2.5.9]

5.1.5.2 Channelled emissions

BAT 24. In order to improve the environmental performance of the incineration plant and to reduce emissions to air, BAT is to optimise the combustion performance, the flue-gas flow through the FGC system, and the injection of reagents by using flow modelling.

Applicability
Generally applicable to new plants and to major retrofits of existing plants.

[This BAT conclusion is based on information given in Section 4.3.2]

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BAT 25. In order to reduce peak emissions to air from the incineration of waste while limiting the consumption of reagents and the amount of residues generated from dry sorbent injection and semi-wet absorbers, BAT is to use technique (a) and also, where appropriate, technique (b) given below.

	Technique	Description	Applicability
a.	Optimised and automated reagent dosage	The use of continuous HCl and/or SO_2 monitoring (or of other parameters that may prove useful for this purpose) upstream and/or downstream of the FGC system for the optimisation of the automated reagent dosage	Generally applicable
b.	Recirculation of reagents	The recirculation of a proportion of the collected FGC solids to reduce the amount of unreacted reagent(s) in the residues. The technique is relevant in particular in the case of FGC techniques with a high stoichiometric ratio	Generally applicable to new plants. Applicable to existing plants within the constraints of the size of the bag filter

[This BAT conclusion is based on information given in Sections 4.5.3.7, 4.5.3.11]

5.1.5.2.1 Emissions of dust, metals and metalloids

BAT 26. In order to reduce emissions to air of dust, metals and metalloids from the incineration of waste, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a.	Bag filter	See Section 5.2.2	Applicable within the constraints associated with the overall pressure drop and the operating temperature profile of the FGC system configuration
b.	Electrostatic precipitator	See Section 5.2.2	Generally applicable
c.	Dry sorbent injection	See Section 5.2.2. Not relevant for the reduction of dust emissions. Adsorption of metals by injection of activated carbon or other reagents	Generally applicable
d.	Wet scrubber	See Section 5.2.2. Wet scrubbers are not used to remove the main dust load but, installed after other abatement techniques, to further reduce the concentrations of dust, metals and metalloids in the flue-gas	There may be economic restrictions to retrofitting existing plants burning non-hazardous waste with a capacity of < 250 000 tonnes/year

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Table 5.2: BAT-associated emission levels (BAT-AELs) for emissions to air of dust, metals and metalloids from incineration

Parameter	BAT-AEL (mg/Nm^3)	Averaging period
Dust	2–5 (1)	Daily average
Cd + Tl	0.01–0.02	Average over the sampling period
Sb + As + Pb + Cr + Co + Cu+ Mn + Ni + V	0.05–0.3	Average over the sampling period
(1) The higher end of the BAT-AEL range is 7 mg/Nm^3 for existing plants where a bag filter is not applicable.		

The associated monitoring is in BAT 5.

[This BAT conclusion is based on information given in Sections 4.5.2.1, 4.5.2.2, 4.5.2.3, 4.5.2.4]

BAT 27. In order to reduce dust emissions to air from the treatment of slags and bottom ashes, BAT is to carry out these activities in enclosed equipment under negative pressure and to treat the extracted air with a bag filter (see Section 5.2.2).

Table 5.3: BAT-associated emission levels (BAT-AELs) for dust emissions to air from the treatment of slags and bottom ashes

Parameter	BAT-AEL (mg/Nm^3)	Averaging period
Dust	2–5	Average over the sampling period

The associated monitoring is in BAT 5.

[This BAT conclusion is based on information given in Section 4.7.9]

5.1.5.2.2 Emissions of HCl, HF and SO_2

BAT 28. In order to reduce emissions of HCl, HF and SO_2 to air from the incineration of waste, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a.	Wet scrubber	See Section 5.2.2	There may be economic restrictions to retrofitting existing plants burning non-hazardous waste with a capacity of < 250 000 tonnes/year
b.	Semi-wet absorber	See Section 5.2.2	Generally applicable
c.	Dry sorbent injection	See Section 5.2.2	Generally applicable
d.	Direct desulphurisation	See Section 5.2.2	Only applicable to fluidised bed furnaces
e.	Boiler sorbent injection	See Section 5.2.2	Generally applicable

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Table 5.4: BAT-associated emission levels (BAT-AELs) for emissions to air of HCl, HF and SO_2 from incineration

Parameter	BAT-AEL (mg/Nm[3])		Averaging period
	New plant	Existing plant	
HCl	2–6 ([1])	2–8 ([1])	Daily average
HF	< 1	< 1	Daily average or average over the sampling period
SO_2	10–30	10–40	Daily average

([1]) The lower end of the BAT-AEL range can be achieved when using a wet scrubber; the higher end of the range may be associated with the use of dry sorbent injection.

The associated monitoring is in BAT 5.

[This BAT conclusion is based on information given in Sections 4.5.3.1, 4.5.3.2, 4.5.3.3, 4.5.3.4, 4.5.3.5, 4.5.3.6, 4.5.3.7, 4.5.3.8, 4.5.3.9, 4.5.3.10]

5.1.5.2.3 Emissions of NO_X, N_2O, CO and NH_3

BAT 29. In order to reduce NO_X emissions to air while limiting the emissions of CO and N_2O from the incineration of waste and the emissions of NH_3 from the use of SNCR and/or SCR, BAT is to use a combination of the techniques given below.

	Technique	Description	Applicability ([1])
a.	Optimisation of the incineration process	See Section 5.2.1	Generally applicable
b.	Flue-gas recirculation	See Section 5.2.2	Generally applicable
c.	Low-NO_X burners	See Section 5.2.2	Only applicable to liquid waste
d.	Selective non-catalytic reduction (SNCR)	See Section 5.2.2	Generally applicable
e.	Selective catalytic reduction (SCR)	See Section 5.2.2	There may be economic restrictions to retrofitting existing plants
f.	Catalytic filter bags	See Section 5.2.2	Not applicable to existing plants that are not fitted with a bag filter
g.	Optimisation of the SNCR/SCR design and operation	Optimisation of the reagent to NO_X ratio, of the homogeneity of reagent distribution and of the size of reagent drops	Only applicable where SNCR and/or SCR is used for the reduction of NO_X emissions

Table 5.5: BAT-associated emission levels (BAT-AELs) for NO_X and CO emissions to air from incineration and for NH_3 emissions from the use of SNCR and/or SCR

Parameter	BAT-AEL (mg/Nm[3])		Averaging period
	New plant	Existing plant	
NO_X	50–120 ([1])	50–150 ([1]) ([2])	Daily average
CO	10–50	10–50	
NH_3	3–10 ([3])	3–10 ([3]) ([4])	

([1]) The lower end of the BAT-AEL range can be achieved when using SCR.
([2]) The higher end of the BAT-AEL range is 180 mg/Nm[3] where SCR is not applicable.
([3]) The lower end of the BAT-AEL range can be achieved when using SCR.
([4]) For existing plants fitted with SNCR without wet abatement techniques, the higher end of the BAT-AEL range is 15 mg/Nm[3].

The associated monitoring is in BAT 5.

[This BAT conclusion is based on information given in Sections 4.3.2, 4.3.4, 4.3.9, 4.3.11, 4.3.12, 4.3.19, 4.3.24, 4.3.25, 4.5.4.1, 4.5.4.2, 4.5.4.3, 4.5.4.4, 4.5.4.5]

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5.1.5.2.4 Emissions of organic compounds

BAT 30. In order to reduce emissions to air of organic compounds including PCDD/F and PCBs from the incineration of waste, BAT is to use techniques (a), (b), (c), (d), and one or a combination of techniques (e) to (i) given below.

	Technique	Description	Applicability
a.	Optimisation of the incineration process	See Section 5.2.1. Optimisation of incineration parameters to promote the oxidation of organic compounds including PCDD/F and PCBs present in the waste, and to prevent their and their precursors' (re)formation	Generally applicable
b.	Control of waste feed	Knowledge and control of the specifications of the waste being fed into the incineration chamber, including their combustion characteristics, to ensure homogeneous, stable and optimal incineration conditions	
c.	On-line and off-line boiler cleaning	Efficient cleaning of the boiler bundles to reduce the dust residence time and accumulation in the boiler, thus reducing PCDD/F formation in the boiler. A combination of on-line and off-line boiler cleaning techniques is used	
d.	Flue-gas quenching	Use of a quench system for the rapid cooling of the flue-gas from temperatures above 400 °C to below 250 °C before dust abatement to prevent the *de novo* synthesis of PCDD/F	
e.	Dry sorbent injection	See Section 5.2.2. Adsorption by injection of activated carbon or other reagents, generally combined with a bag filter where a reaction layer is created in the filter cake and the solids generated are removed	
f.	Fixed-bed adsorption	Adsorption by passing the flue-gas through a fixed-bed filter where activated coke or activated lignite is used as the adsorbent	The applicability may be limited by the overall pressure drop associated with the flue-gas cleaning system configuration
g.	Multi-layer SCR	Where SCR is used for NO_X abatement, the adequate sizing of a multi-layer SCR system provides for effective PCDD/F and PCB control	There may be economic restrictions to retrofitting existing plants
h.	Catalytic filter bags	See Section 5.2.2	Not applicable to existing plants that are not fitted with a bag filter
i.	Carbon adsorption in wet scrubber	PCDD/F and PCBs are adsorbed by carbon sorbent added to the wet scrubber, either in the scrubbing liquor or in the form of impregnated packing elements. The technique is particularly used to prevent and/or reduce the re-emission of PCDD/F accumulated in the scrubber (the so-called memory effect) occurring especially during shutdown and start-up periods	Not applicable to existing plants that are not fitted with a wet scrubber

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Table 5.6: BAT-associated emission levels (BAT-AELs) for emissions to air of TVOC, PCDD/F and dioxin-like PCBs from incineration

Parameter	Unit	BAT-AEL		Averaging period
		New plant	Existing plant	
TVOC	mg/Nm^3	3–10	3–10	Daily average
PCDD/F ([1])	ng I-TEQ/Nm^3	< 0.01–0.04	< 0.01–0.06	Average over the sampling period or long-term sampling average
PCDD/F + dioxin-like PCBs ([1])	ng WHO-TEQ/Nm^3	< 0.01–0.06	< 0.01–0.08	Average over the sampling period or long-term sampling average
([1]) Either the BAT-AEL for PCDD/F or the BAT-AEL for PCDD/F + dioxin-like PCBs applies.				

The associated monitoring is in BAT 5.

[This BAT conclusion is based on information given in Sections 4.3.7, 4.3.6, 4.3.19, 4.4.19, 4.5.5.2, 4.5.5.3, 4.5.5.4, 4.5.5.6, 4.5.5.7, 4.5.5.8, 4.5.5.9]

5.1.5.2.5 Emissions of mercury

BAT 31. In order to reduce mercury emissions to air from the incineration of waste, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a.	Wet scrubber (low pH)	See Section 5.2.2. A wet scrubber operated at a pH value below 1. The mercury removal rate of the technique can be enhanced by adding reagents and/or adsorbents to the scrubbing liquor, e.g.: • oxidants such as hydrogen peroxide to transform metallic mercury to a water-soluble oxidised form • sulphur compounds • carbon sorbent to adsorb metallic mercury	There may be economic restrictions to retrofitting existing plants burning non-hazardous waste with a capacity of < 250 000 tonnes/year
b.	Boiler bromine addition	Bromide added to the waste or injected into the furnace is dissociated at high temperatures into elemental bromine to enhance the oxidisation of mercury while the flue-gas passes through the boiler, thereby promoting the transformation of elemental gaseous mercury to $HgBr_2$, which is water-soluble and highly adsorbable. The technique is used in combination with a downstream abatement technique such as a wet scrubber or an activated carbon injection system	Generally applicable
c.	Dry sorbent injection	See Section 5.2.2. Adsorption by injection of activated carbon or other reagents, generally combined with a bag filter where a reaction layer is created in the filter cake and the solids generated are removed	Generally applicable
d.	Fixed-bed adsorption	Adsorption by passing the flue-gas through a fixed-bed filter where activated coke or activated lignite is used as the adsorbent	The applicability may be limited by the overall pressure drop associated with the flue-gas cleaning system configuration

Table 5.7: BAT-associated emission levels (BAT-AELs) for emissions of mercury to air from incineration

Parameter	BAT-AEL (µg/Nm³)		Averaging period
	New plant	Existing plant	
Hg	5–20	5–25	Daily average, Long-term sampling average, or Average over the sampling period
NB: The lower end of the BAT-AEL ranges can be achieved when using fixed-bed adsorption or a wet scrubber enhanced with the use of oxidants; the higher end of the BAT-AEL ranges can be achieved when using dry sorbent injection.			

As an indication, the half-hourly average mercury emission levels will generally be:

- 15–40 µg/Nm^3 for existing plants
- 15–35 µg/Nm^3 for new plants.

The associated monitoring is in BAT 5.

[This BAT conclusion is based on information given in Sections 4.5.5.7, 4.5.6.1, 4.5.6.2, 4.5.6.3, 4.5.6.5, 4.5.6.6, 4.5.6.7, 4.5.6.8]

5.1.6 Emissions to water

BAT 32. In order to prevent the contamination of uncontaminated water and to reduce emissions to water, BAT is to segregate waste water streams and to treat them separately, depending on the pollutant content.

Description
Waste water streams (e.g. surface run-off water, cooling water, waste water from flue-gas treatment and from bottom ash treatment) are segregated to be treated separately based on their pollutant content and on the combination of treatment techniques required. Uncontaminated water streams are segregated from waste water streams that require treatment.

Applicability
Generally applicable to new plants.

Applicable to existing plants within the constraints associated with the configuration of the water collection system.

[This BAT conclusion is based on information given in Sections 4.6.9 and 4.6.14]

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BAT 33. In order to reduce water usage and to prevent or reduce the generation of waste water from the incineration plant, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a.	Waste-water-free FGC techniques	Use of FGC techniques that do not generate waste water (e.g. dry sorbent injection or semi-wet absorber, see Section 5.2.2)	Generally applicable
b.	Recycling of boiler drain water	Recycling of boiler drain water (e.g. for its use in a wet scrubber, or a quench system)	Generally applicable
c.	Recycling of waste water from the wet scrubber	The waste water originating from the wet scrubber is treated and recycled to the wet scrubber	Only applicable to plants fitted with a wet scrubber

[This BAT conclusion is based on information given in Sections 4.6.3, 4.6.6, 4.6.8]

BAT 34. In order to reduce emissions to water from flue-gas cleaning and/or from the treatment of slags and bottom ashes, BAT is to use an appropriate combination of the techniques given below, and to use secondary techniques as close as possible to the source in order to avoid dilution.

	Technique	Typical pollutants prevented/abated
Primary techniques		
a.	Optimisation of the incineration process (see BAT 15) and/or of flue-gas treatment systems (e.g. SNCR/SCR, see BAT 29 (g))	Organic compounds including PCDD/F, ammonia
b.	Separate treatment of waste water arising from different wet scrubbing stages (acidic and alkaline)	Acids, alkalis, sulphate
Secondary techniques ([1])		
Preliminary and primary treatment		
c.	Equalisation	All pollutants
d.	Neutralisation	Acids, alkalis
e.	Physical separation, e.g. screens, sieves, grit separators, primary settlement tanks	Gross solids, suspended solids
Physico-chemical treatment		
f.	Adsorption on activated carbon	Organic compounds including PCDD/F, mercury
g.	Chemical precipitation	Dissolved metals/metalloids, sulphate
h.	Oxidation	Sulphide, sulphite, organic compounds
i.	Ion exchange	Dissolved metals/metalloids
j.	Stripping	Ammonia/ammonium
k.	Reverse osmosis	Ammonia/ammonium
Final solids removal		
l.	Coagulation and flocculation	Suspended solids, particulate-bound metals/metalloids
m.	Sedimentation	Suspended solids, particulate-bound metals/metalloids
n.	Filtration	Suspended solids, particulate-bound metals/metalloids
o.	Flotation	Suspended solids, particulate-bound metals/metalloids
([1]) The descriptions of the techniques are given in Section 5.2.3.		

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Table 5.8: BAT-AELs for direct emissions to a receiving water body

Parameter		Process	Unit	BAT-AEL (daily average)
Total suspended solids (TSS)		FGC Bottom ash treatment	mg/l	10–30
Total organic carbon (TOC)		FGC Bottom ash treatment		15–40
Metals and metalloids	As	FGC		0.01–0.05
	Cd	FGC		0.005–0.03
	Cr	FGC		0.02–0.08
	Cu	FGC		0.03–0.15
	Hg	FGC		0.001–0.01
	Ni	FGC		0.03–0.15
	Pb	FGC Bottom ash treatment		0.02–0.08
	Tl	FGC		0.005–0.03
	Zn	FGC		0.01–0.5
NH_4-N		Bottom ash treatment		10–30
SO_4^{2-}		Bottom ash treatment		400–1000
PCDD/F		FGC Bottom ash treatment	ng I-TEQ/l	0.01–0.1

The associated monitoring is in BAT 7.

[This BAT conclusion is based on information given in Sections 4.6.10, 4.6.11, 4.6.12, 4.6.13, 4.7.10]

5.1.7 Material efficiency

BAT 35. In order to increase resource efficiency and improve the recovery of useful materials from the incineration residues, BAT is to handle and treat bottom ashes separately from fly ashes and from other FGC residues, and to use a combination of the techniques given below.

	Technique	Description	Applicability
a.	Screening and sieving	Oscillating screens, vibrating screens and rotary screens are used for an initial classification by size before further treatment	Generally applicable
b.	Aeraulic separation	Aeraulic separation uses differences in density, particle size and particle shape to sort commingled materials. A narrow range of particle sizes is needed for effective separation.	Generally applicable
c.	Recovery of ferrous and non-ferrous metals	Different techniques are used, including: • magnetic separation for ferrous metals • eddy current separation non-ferrous metals • induction all-metal separation	Generally applicable
d.	Ageing	The ageing process stabilises the mineral fraction of the bottom ashes by uptake of atmospheric CO2, draining of excess water and oxidation. Bottom ashes, after metal separation, are stored in open air or in covered buildings for several weeks, generally on a concrete floor allowing for drainage and run-off water to be	Generally applicable

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		collected for treatment. The stockpiles may be wetted, if required, to prevent dust emissions and to favour the leaching of salts and the carbonisation if the bottom ashes are not sufficiently wet.	
e.	Washing	Washing of bottom ashes enables the production of a material for recycling with minimal leachability of metals and anions (e.g. salts).	Generally applicable
f.	Crushing	Mechanical treatment operations intended to prepare materials for subsequent use, e.g. road and earthworks construction.	Generally applicable

[This BAT conclusion is based on information given in Section 4.7.2, 4.7.4, 4.7.5, 4.7.7, 4.7.8]

5.1.8 Noise and vibration

BAT 36. In order to prevent or, where that is not practicable, to reduce noise and vibration emissions, BAT is to use one or a combination of the techniques given below.

Technique		Description	Applicability
a.	Appropriate location of equipment and buildings	Noise levels can be reduced by increasing the distance between the emitter and the receiver and by using buildings as noise screens	Generally applicable to new plants. In the case of existing plants, the relocation of equipment may be restricted by lack of space or by excessive costs
b.	Operational measures	These include: • improved inspection and maintenance of equipment • closing of doors and windows of enclosed areas, if possible • equipment operated by experienced staff • avoidance of noisy activities at night, if possible • provisions for noise control during maintenance activities	Generally applicable
c.	Low-noise equipment	This includes low-noise compressors, pumps and fans	Generally applicable when the equipment is new or replaced
d.	Noise attenuation	Noise propagation can be reduced by inserting obstacles between the emitter and the receiver. Appropriate obstacles include protection walls, embankments and buildings	Generally applicable to new plants. In the case of existing plants, the insertion of obstacles may be restricted by lack of space
e.	Noise-control equipment/ infrastructure	This includes: • noise-reducers • equipment insulation • enclosure of noisy equipment • soundproofing of buildings	Generally applicable to new plants. In the case of existing plants, the applicability may be restricted by lack of space

[This BAT conclusion is based on information given in Section 4.8]