6 BEST AVAILABLE TECHNIQUES (BAT) CONCLUSIONS

This section has been completely rewritten compared to the original WT BREF

Scope

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

- *5.1. Disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day involving one or more of the following activities:*
  - *(a) biological treatment;*
  - *(b) physico-chemical treatment;*
  - *(c) blending or mixing prior to submission to any of the other activities listed in points 5.1 and 5.2* [of Annex I to Directive 2010/75/EU]*;*
  - *(d) repackaging prior to submission to any of the other activities listed in points 5.1 and 5.2* [of Annex I to Directive 2010/75/EU]*;*
  - *(e) solvent reclamation/regeneration;*
  - *(f) recycling/reclamation of inorganic materials other than metals or metal compounds;*
  - *(g) regeneration of acids or bases;*
  - *(h) recovery of components used for pollution abatement;*
  - *(i) recovery of components from catalysts;*
  - *(j) oil re-refining or other reuses of oil;*

- *5.3*
  - *(a) Disposal of non-hazardous waste with a capacity exceeding 50 tonnes per day involving one or more of the following activities, and excluding activities covered by Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment:*
    - *(i) biological treatment;*
    - *(ii) physico-chemical treatment;*
    - *(iii) pre-treatment of waste for incineration or co-incineration;*
    - *(iv) treatment of* […] *ashes;*
    - *(v) treatment in shredders of metal waste, including waste electrical and electronic equipment and end-of-life vehicles and their components.*
  - *(b) Recovery, or a mix of recovery and disposal, of non-hazardous waste with a capacity exceeding 75 tonnes per day involving one or more of the following activities, and excluding activities covered by Directive 91/271/EEC:*
    - *(i) biological treatment;*
    - *(ii) pre-treatment of waste for incineration or co-incineration;*
    - *(iii) treatment of* […] *ashes;*
    - *(iv) treatment in shredders of metal waste, including waste electrical and electronic equipment and end-of-life vehicles and their components.*

    When the only waste treatment activity carried out is anaerobic digestion, the capacity threshold for this activity shall be 100 tonnes per day.

- *5.5. Temporary storage of hazardous waste not covered under point 5.4* [of Annex I to Directive 2010/75/EU] *pending any of the activities listed in points 5.1, 5.2, 5.4 and 5.6* [of Annex I to Directive 2010/75/EU] *with a total capacity exceeding 50 tonnes, excluding temporary storage, pending collection, on the site where the waste is generated.*
- 6.11 *Independently operated treatment of waste water not covered by Directive 91/271/EEC and discharged by an installation* [undertaking activities covered under points 5.1, 5.3 and 5.5 above].

These BAT conclusions do not address the following:

- surface impoundment of waste;
- disposal or recycling of animal carcases or animal waste;
- direct recovery (i.e. without pretreatment) of waste as a substitute for raw materials in installations performing activities covered in other BAT conclusions, i.e. direct recovery of lead batteries, zinc or aluminium salts or recovery of the metals from catalysts covered in the BAT conclusions for the non-ferrous metals industries; paper waste recycling covered in the BAT conclusions for the production of pulp, paper and board; use of waste as raw material in cement kiln covered in the BAT conclusions for the production of cement, lime and magnesium oxide;
- waste incineration, co-incineration, pyrolysis and gasification;
- landfill of waste;
- in situ remediation of contaminated soil (i.e. unexcavated);
- treatment of slags and bottom ash.

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

Reference document	Subject
Economics and Cross-Media Effects (ECM)	Economics and cross-media effects of techniques
Emissions from Storage (EFS)	Storage, transfer and handling of solids and liquids
Energy Efficiency (ENE)	General aspects of energy efficiency
Monitoring of emissions to air and water from IED installations (ROM)	Monitoring of emissions to air and water
Production of Cement, Lime and Magnesium Oxide (CLM)	Waste quality control and safety management for the use of hazardous waste materials
Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (CWW)	Waste water treatment techniques and treatment of water-based liquid waste

These BAT conclusions apply without prejudice to other relevant legislation, e.g. on health and safety.

Definitions

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

Term used	Definition
Continuous measurement	Measurement using an 'automated measuring system' permanently installed on site
Diffuse emissions	Non-channelled emissions (e.g. of dust, VOC) which can result from 'area' sources (e.g. tanks) or 'point' sources (e.g. pipe flanges)
Emission Factors	Numbers that can be multiplied by known data such as plant/process activity data or throughput data to estimate emissions
Existing plant	A plant that is not a new plant
Flaring	High-temperature oxidation to burn combustible compounds of waste gases from industrial operations with an open flame. Flaring is primarily used for burning off flammable gas for safety reasons or during non-routine operating conditions.
Fugitive emissions	Diffuse emissions from 'point' sources
Laboratory smalls	Laboratory chemicals in containers of a small capacity
Mechanical Biological Treatment' (MBT)	Treatment of solid waste combining mechanical treatment (e.g. shredding) with biological treatment such as aerobic or anaerobic treatment
New plant	A plant first permitted at the site of the installation following the publication of these BAT conclusions or a complete replacement of a plant following the publication of these BAT conclusions
Pasty waste	Non-pumpable waste (e.g. sludge)
Periodic measurement	Determination of a measure (particular quantity subject to measurement) at specified time intervals using manual or automated methods
Recovery	Recovery as defined in Article 3(15) of Directive 2008/98/EC
Re-refining	Treatments carried out to waste oil to be transformed to base oil
Regeneration	Treatments and processes mainly designed to make the treated equipment (e.g. activated carbon) or material (e.g. spent solvent) usable again
Residues	Materials generated by the activities covered by the scope of this document, as waste or by-products.
Sensitive receptor	Area which needs special protection, such as: - residential areas; - areas where human activities are carried out (e.g. schools, daycare centres, recreational areas, hospitals or nursing homes).
Treatment of waste with calorific value	Treatment of waste wood, waste oil, waste plastics, waste solvents, etc. to obtain a fuel or to allow a better recovery of its calorific value
Waste holder	Waste holder as defined in Article 3(6) of Directive 2008/98/EC
Waste input	The incoming waste to be treated in the waste treatment plant

Comment [EN1]: This table doesn't include terms for anaerobic biological treatment of liquid / pumpable biodegradable wastes and, the far less common, aerobic biological treatment of liquid / pumpable biodegradable wastes. It should do because many aspects of BAT monitoring are applicable to these types of treatment process.

The definition of MBT covers solid wastes only, as currently drafted.
Additionally, the MBT definition appears to be applicable to mechanical and biological treatment of any type(s) of solid waste, not just mixtures of solid wastes that include a non-biodegradable fraction when the waste is delivered to the facility*. This is potentially OK in the BAT context but means that this chapter needs to take care to use the correct term in all relevant places.

* Section 4's chapter 4.4.1 states: 'Mechanical biological treatment (MBT) is usually designed to recover materials for one or more purposes and to stabilise the organic fraction of the residual waste.' It's text is not providing a definition but it's clearly different from chapter 6's definition of MBT and the scope it implies (inclusion of facilities that compost or digest only source separated biodegradable wastes).

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

Parameters	Definition
Arsenic	Arsenic, expressed as As, includes all inorganic and organic arsenic compounds, dissolved or bound to particles
Cadmium	Cadmium, expressed as Cd, includes all inorganic and organic cadmium compounds, dissolved or bound to particles
Chromium	Chromium, expressed as Cr, includes all inorganic and organic chromium compounds, dissolved or bound to particles
COD	Chemical oxygen demand. Amount of oxygen needed for the total oxidation of the organic matter to carbon dioxide. COD is an indicator for the mass concentration of organic compounds
Copper	Copper, expressed as Cu, includes all inorganic and organic copper compounds, dissolved or bound to particles
Hydrocarbon oil index (HOI)	The sum of compounds extractable with a hydrocarbon solvent (including long-chain or branched aliphatic, alicyclic, aromatic or alkyl-substituted aromatic hydrocarbons)
Lead	Lead, expressed as Pb, includes all inorganic and organic lead compounds, dissolved or bound to particles
Mercury	Mercury, expressed as Hg, includes all inorganic and organic mercury compounds, dissolved or bound to particles
Nickel	Nickel, expressed as Ni, includes all inorganic and organic nickel compounds, dissolved or bound to particles
PCBs	Polychlorinated biphenyls
Phenol index	The sum of phenolic compounds, expressed as phenol
TOC	Total organic carbon, expressed as C (in water), includes all organic compounds
Total N	Total nitrogen, expressed as N, includes free ammonia and ammonium nitrogen (NH_4–N), nitrite nitrogen (NO_2–N), nitrate nitrogen (NO_3–N) and organically bound nitrogen
Total P	Total phosphorus, expressed as P, includes all inorganic and organic phosphorus compounds, dissolved or bound to particles
Total suspended solids (TSS)	Mass concentration of all suspended solids (in water), measured via filtration through glass fibre filters and gravimetry
TVOC	Total volatile organic compounds as measured by a flame ionisation detector (FID) and expressed as total C (in air)
VOC	Volatile Organic Compound as defined in Article 3(45) of Directive 2010/75/EU
Zinc	Zinc, expressed as Zn, includes all inorganic and organic zinc compounds, dissolved or bound to particles

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

Acronym	Definition
APC	Air pollution control
EMS	Environmental management system
EoLV	End-of-life vehicles (as defined in Article 2(2) of Directive 2000/53/EC)
FGT	Flue-gas treatment
HEPA	High-efficiency particle air filter
IBC	Intermediate bulk container
LDAR	Leak detection and repair
LEV	Local exhaust ventilation system
MBT	Mechanical biological treatment
MSW	Municipal solid waste
POP	Persistent organic pollutant
VHC	Volatile hydrocarbon
VFC	Volatile fluorocarbon
WT	Waste treatment
WWTP	Waste water treatment plant

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.

Comment [JJ2]: This text important as it indicates that other options are available as long as the outcome produced is the same in respect to the level of protection it offers to the environment.

Unless otherwise stated, the BAT conclusions are generally applicable.

[NOTE: Whilst cross-references are provided to other parts of this document in order to aid the work of the TWG, they will not be included in the final BAT conclusions themselves. Such cross-references are consequently displayed in *italic green* between square brackets.]

[TWG: please note that in order to avoid repetition, this section contains general considerations that are essential to the understanding of the BAT conclusions taken as a stand-alone document, such as:

- reference conditions for air emissions (e.g. dry gas, standard temperature/pressure, oxygen concentration)
- averaging periods
- sampling times
- conversions to reference conditions
- adopted units of measures]

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

Unless stated otherwise, emission levels associated with the best available techniques (BAT-AELs) for emissions to air given in these BAT conclusions refer to concentrations (mass of emitted substance per volume of waste gas) under the following standard conditions: dry gas at a temperature of 273.15 K and a pressure of 101.3 kPa, without correction for O_2, and expressed in µg/Nm^3 or mg/Nm^3.

For averaging periods of BAT-AELs for emissions to air, the following **definition** applies:

Averaging period	Definition
Average of values obtained during one year	Average of all valid measurement values obtained during one year

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

Unless stated otherwise, 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 water), expressed in mg/l.

Unless stated otherwise, the BAT-AELs refer to the flow-weighted monthly average values of all the following samples taken during that period under normal operating conditions.

2. for a continuous discharge or batch discharge with a duration of 24 hours or more: 24-hour flow-proportional composite samples,
3. for a batch discharge with a duration of less than 24 hours: flow-proportional composite samples taken over the discharge period,

Time-proportional composite sampling can be used provided that sufficient flow stability is demonstrated.

The flow-weighted monthly average concentration (c_w) is calculated using the following equation:

$$c_w = \frac{\sum_{i=1}^{n} q_i c_i}{\sum_{i=1}^{n} q_i}$$

Where

n	=	number of measurements;
c_i	=	average concentration during ith measurement;
q_i	=	average flow rate during ith measurement.

6.1 General BAT conclusions

6.1.1 Overall environmental performance

6.1.1.1 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:

Comment [JJ3]: Permitted sites will have a requirement to provide this information as routine already so I do not see this as problematic.
Please comment if you do think this is the case.

I. commitment of the management, including senior management;
II. definition of an environmental policy that includes the continuous improvement of the installation by the management;
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) 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 Reference Report on Monitoring),
 (b) corrective and preventive action,
 (c) maintenance of records,
 (d) 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;

VI. review of the EMS and its continuing suitability, adequacy and effectiveness by senior management;
VII. following the development of cleaner technologies;
VIII. consideration for the environmental impacts from the eventual decommissioning of the plant at the stage of designing a new plant, and throughout its operating life;
IX. application of sectoral benchmarking on a regular basis.

X. waste treatment strategy that includes inventories of waste input streams (see BAT 2 and BAT 14);
XI. procedures to ensure the compatibility of wastes before mixing/blending (see BAT 2);
XII. odour management plan (see BAT 8);
XIII. noise and vibration management plan (see BAT 18);
XIV. residues management plan (see description in Section 6.6.4);
XV. accident management plan (see description in Section 6.6.4).

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 (determined also by the type and amount of wastes processed).

[This BAT conclusion is based on information given in Sections 2.3.1.1 and 2.3.1.2]

6.1.1.2 Waste stream management

BAT 2. In order to improve the overall environmental performance, BAT is to use all of the techniques given below.

	Technique	Description
a	To implement waste characterisation and pre-acceptance procedures	These procedures aim to ensure the technical (and legal) suitability of waste treatment operation for a particular waste prior to the arrival of the waste at the plant. It includes procedures to collect information about the waste to be treated and may include waste sampling and characterisation to achieve sufficient knowledge of the waste composition.
b	To implement waste acceptance procedures	Acceptance procedures aim to confirm the characteristics of the waste, as identified in the pre-acceptance stage. The procedures define the elements to be verified upon waste arrival at the plant as well as the waste rejection criteria. They may include waste sampling, inspection and analysis.
c	To implement a waste tracking system and inventory	A waste tracking system aims to keep control on the location and quantity of waste in the plant. It holds all the information generated (e.g. date of arrival on site, unique reference number, producer details, pre-acceptance and acceptance analysis results, intended treatment route, nature and quantity of waste held on site including all identified hazards) during waste pre-acceptance, acceptance, storage, treatment and/or transfer off-site.
d	To ensure waste segregation	Waste is separated prior to treatment depending on its properties in order to enable easier and environmentally safer treatment. Waste segregation relies on the physical separation of waste and on procedures that define when the mixing of waste is allowed and how it is carried out.
e	To assess waste compatibility	Compatibility assessment consists of a set of verification measures and tests in order to detect any unwanted and potentially dangerous chemical reactions between wastes (polymerisation, gas evolution, exothermal reaction, decomposition, crystallisation, precipitation, etc.) when mixing, blending or carrying out other treatment operations.

Comment [JJ4]: Not sure that ALL of these will be applicable to biological treatment of waste. Observation, so no comments required.

f	To sort incoming waste	Waste sorting[(1)] aims to prevent unwanted material to enter the waste treatment process. may include: • Manual separation by means of visual examinations to sort out the recyclables and contaminants; • Ferrous metals, non-ferrous metals or all-metals separators; • Optical separation by e.g. Near Infrared spectroscopy or X-ray systems; • Density separation by e.g. air classification, sink-float tanks, vibration tables; • Size separation by screening/sieving.
[(1)]Sorting techniques are described in Section 6.6.3		

[This BAT conclusion is based on information given in Sections 2.3.2.1, 2.3.2.2, 2.3.2.3, 2.3.2.4, 2.3.2.5, 2.3.2.6, 2.3.2.7, and 2.3.2.8]

6.1.1.3 Monitoring

BAT 3. BAT is to monitor emissions to water with at least the frequency indicated in , Table 6.1 and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.

Table 6.1: Monitoring of emissions to water

Substance / parameter	Standard(s)	Waste treatment process	Minimum monitoring frequency (1) (2) (3)
Total organic carbon (TOC) (4)	EN 1484	All treatments of waste except physico-chemical and/or biological treatment of water-based liquid waste	Once every week
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Chemical oxygen demand (COD) (4)	No EN standard available	All treatments of waste except physico-chemical and/or biological treatment of water-based liquid waste	Once every week
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Total suspended solids (TSS)	EN 872	All treatments of waste except physico-chemical and/or biological treatment of water-based liquid waste	Once every week

Comment [JJ5]: Please indicate if you see any issues arising from the highlighted text below which are the ones which apply to biodegradable waste treatment.

Comment [JG6]: Need some feedback from AD operators if once per day is usual or if it is going to be more onerous.

Comment [EN7]: Each time 'once every day is specified' this should be 'once every working day'.

		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Hydrocarbon oil index (HOI)	EN ISO 9377-2	Mechanical treatment in shredder of metal waste	Once every week
		Re-refining of waste oil	
		Physico-chemical treatment of waste with calorific value	
Total nitrogen (TN)	EN 12260	Biological treatment of waste	Once every week
		Re-refining of waste oil	
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Total phosphorus (TP)	Various EN standards available (e.g. EN ISO 15681-1 and -2, EN ISO 6878, EN ISO 11885)	Biological treatment of waste	Once every week
		Re-refining of waste oil	
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Phenol index	EN ISO 14402	Re-refining of waste oil	Once every week
		Physico-chemical treatment of waste with calorific value	
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Arsenic (As) ([5])	Various EN standards available (e.g. EN ISO 11885, EN ISO 17294-2, EN ISO 15585)	Mechanical treatment in shredder of metal waste	Once every week
		Mechanical biological treatment of waste	
		Re-refining of waste oil	
		Water washing of excavated contaminated soil	
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Cadmium (Cd) ([5])		Mechanical treatment in shredder of metal waste	Once every week
		Mechanical biological treatment of waste	
		Re-refining of waste oil	
		Water washing of excavated contaminated soil	
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Chromium (Cr) ([5])		Mechanical treatment in shredder of metal waste	Once every week
		Mechanical biological treatment of waste	
		Re-refining of waste oil	

Comment [JJ8]: Applies to all PTEs shown below **No comment required**

Comment [EN9]: **Question for the Bref team.** Can the daily PTE tests be done at the waste site? The lab equipment for reading concentration in the prepared solution is expensive, so it's likely that samples will have to be sent to a commercial lab for testing.
There is potential for commercial labs to considerably reduce their charge per sample tested and shorten the time between receiving the sample and reporting the test result IF the number of samples to be tested is large over a given period of time. Dialogue with commercial labs is needed.
Even with reduced times between sampling and receiving the test result , if a result shows that a PTE emission to water is too high, the best the waste site operator can do is take immediate action (after receiving the test result) to reduce the relevant PTE's concentration in further emissions to water. **No comments by members required**

		Water washing of excavated contaminated soil	
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Copper (Cu) (5)		Mechanical treatment in shredder of metal waste	Once every week
		Mechanical biological treatment of waste	
		Re-refining of waste oil	
		Water washing of excavated contaminated soil	
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Nickel (Ni) (5)		Mechanical treatment in shredder of metal waste	Once every week
		Mechanical biological treatment of waste	
		Re-refining of waste oil	
		Water washing of excavated contaminated soil	
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Lead (Pb) (5)		Mechanical treatment in shredder of metal waste	Once every week
		Mechanical biological treatment of waste	
		Re-refining of waste oil	
		Water washing of excavated contaminated soil	
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Zinc (Zn) (5)		Mechanical treatment in shredder of metal waste	Once every week
		Mechanical biological treatment of waste	
		Re-refining of waste oil	
		Water washing of excavated contaminated soil	
		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
Mercury (Hg) (5)	Various EN standards available (e.g. EN ISO 17852, EN ISO 12846)	Mechanical treatment in shredder of metal waste	Once every week
		Mechanical biological treatment of waste	
		Re-refining of waste oil	
		Water washing of excavated contaminated soil	

		Physico-chemical and/or biological treatment of water-based liquid waste	Once every day
(1) Monitoring frequencies may be adapted if the data series clearly demonstrate a sufficient stability of emissions over time. (2) The sampling point is located where the emission leaves the installation. (3) In the case of batch discharge with a duration < 24 hours, once per batch discharge. (4) Either TOC or COD is monitored. TOC is the preferred option, because its monitoring does not rely on the use of very toxic compounds. (5) The monitoring may not apply when the substance concerned is not present in the waste to be treated.			

[This BAT conclusion is based on information given in Section 2.3.3.2]

BAT 4. BAT is to monitor emissions to air with at least the frequency indicated in Table 6.2, 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.

Comment [JJ10]: **Comments required**: Members, please indicate which of these you currently carry out and at what frequency.

Table 6.2: Monitoring of channelled emissions to air

Parameter	Standard(s)	Waste treatment process	Monitoring associated with	Minimum monitoring frequency ([1])
Dust	EN 13284-1	Mechanical treatment of waste	BAT 25	Once every six months
		Mechanical biological treatment of waste	BAT 37	Once every three months
		Physico-chemical treatment of solid and/or pasty waste	BAT 39	Once every six months
		Thermal treatment of spent activated carbon, waste catalysts and excavated contaminated soil	NA	
		Treatment of excavated contaminated soil	NA	
TVOC	EN 12619	Mechanical treatment in shredder of equipment containing VFCs and/or VHCs	BAT 29	Once every six months
		Mechanical biological treatment of waste	BAT 37	Once every three months
		Physico-chemical treatment of solid and/or pasty waste	BAT 39	Once every six months
		Re-refining of waste oil	BAT 41	
		Physico-chemical treatment of waste with calorific value	BAT 43	
		Regeneration of spent solvents	BAT 45	
		Thermal treatment of spent activated carbon, waste catalysts and excavated contaminated soil	NA	
		Treatment of excavated contaminated soil	NA	
		Physico-chemical and/or biological treatment of water-based liquid waste	BAT 52	
		Decontamination of equipment containing POPs ([3])	NA	
NH_3	No EN standard	All biological treatments of waste	BAT 32	Once every three months

Comment [JJ11]: This is not currently carried out to my knowledge at any sites in the UK on a routine basis. **Members Please comment**

	available	Physico-chemical treatment of solid and/or pasty waste	BAT 39	Once every six months
		Physico-chemical and/or biological treatment of water-based liquid waste	BAT 52	
H_2S	No EN standard available	All biological treatments of waste	BAT 32	Once every three months
HCl	EN 1911	Thermal treatment of spent activated carbon, waste catalysts and excavated contaminated soil	NA	Once every six months
		Physico-chemical and/or biological treatment of water-based liquid waste	BAT 52	
HF	ISO 15713	Thermal treatment of spent activated carbon, waste catalysts and excavated contaminated soil	NA	Once every six months
Hg (total)	EN 13211	Treatment of mercury-containing waste	BAT 30	Once every six months
PCBs	EN 1948-1, -2, and -4 (2)	Decontamination of equipment containing POPs	NA	Once every six months
Relevant metals and metalloids except mercury (e.g. As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Sb, Se, Tl, V)	EN 14385	Mechanical treatment in shredder of metal waste	NA	Once every six months

NA: Not applicable
(1) Monitoring frequencies may be adapted if the data series clearly demonstrate a sufficient stability.
(2) Instead of EN 1948-1, sampling may also be carried out with CEN/TS 1948-5.
(3) When solvent is used for cleaning the contaminated devices.

[This BAT conclusion is based on information given in Section 2.3.3.3]

BAT 5. BAT is to monitor diffuse VOCs emissions to air from the regeneration of spent solvents and the solvent-using decontamination of equipment containing POPs at least once per year using one or a combination of the techniques given below.

	Technique	Description
a	Measurement	Sniffing, optical gas imaging, solar occultation flux or differential adsorption. See descriptions in Section 6.6.1
b	Emissions factors	Calculation of emissions based on emissions factors, periodically validated (e.g. once every two years) by measurements.
c	Solvent mass balance	Calculation of diffusion emissions using a mass balance considering the solvent input, channelled emissions to air, emissions to water, solvent in output, and process (e.g. distillation) residues.

[This BAT conclusion is based on information given in Sections 5.4.3.2 and 5.8.1.3.2]

BAT 6. BAT is to periodically monitor odour emissions from relevant sources in accordance with EN standards.

Comment [JJ12]: How often does 'periodically' mean? **No member comment required**

Description

Emissions can be monitored by dynamic olfactometry according to EN 13725.

Comment [JJ13]: Is this the current methodology used routinely by labs in the UK? **Members please comment**

Applicability

The applicability is restricted to cases where odour nuisance can be expected or has been substantiated.

[This BAT conclusion is based on information given in Section 2.3.3.4]

BAT 7. BAT is to monitor water consumption, energy consumption, raw material consumption, sludge generation, residue generation, and the amount of waste water generated, all broken down by process, with a frequency of at least once per year, and considering any significant changes in plant operation.

[This BAT conclusion is based on information given in Sections 2.3.7, 2.3.8, and 2.3.9)

6.1.2 Odorous and diffuse emissions to air

BAT 8. In order to prevent or, where that is not practicable, to reduce odorous emissions from the plant, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements:

- a protocol containing actions (see BAT 9) and timelines;
- a protocol for conducting odour monitoring as set out in BAT 6. It may be complemented by measurement/estimation of odour exposure or estimation of odour impact;
- a protocol for response to identified odour incidents;
- 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.

Applicability

The applicability is restricted to cases where odour nuisance can be expected and/or has been substantiated.

[This BAT conclusion is based on information given in Sections 2.3.3.4, 2.3.5.1 and 4.5.1.3].

BAT 9. In order to prevent or, where that is not practicable, to reduce odorous emissions, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a	Minimise residence times	Minimise the residence time of odorous waste and potentially odorous waste in collection and storage systems, in particular under anaerobic conditions. When relevant, adequate provisions are made for the acceptance of seasonal peak volumes of waste.	Generally applicable.
b	Chemical treatment	Use chemicals to destroy or to reduce the formation of odorous compounds (e.g. oxidation or precipitation of hydrogen sulphide).	Generally applicable.

Comment [JJ14]: This would seem to indicate that if an operator and/or the regulator expects odour nuisance to occur (a complaint that is likely to be substantiated) odour emissions must be monitored. Regulators might take a very conservative approach, requiring permanent odour emissions monitoring at an agreed frequency, at most sites where biodegradable wastes are treated at a scale where to BAT applies.
Similarly, if an odour compliant is substantiated this will trigger the monitoring of odour emissions.
JJ to seek clarification on this. No member comment required.

Comment [JJ15]: This could be quite an onerous requirement given the significant volumes of water used in biological waste treatment both as an additive to the process and for wash down and site hygiene. **Members, please comment and indicate whether you carry out anything similar currently.**

Comment [JJ16]: OMPs are routinely requested at biological treatment sites so I do not see this as being of concern. **Members, please indicate if the requirements set out below are more onerous than your current OMP requires.**

Comment [JJ17]:
If an odour nuisance is EXPECTED the operator has to do his OMP. Conservatively, if the local EA officer thinks that an odour compliant is likely to be made (that in due course would be substantiated), the operator has to have, use and review his OMP. **No comments required by members, for information only**

Comment [JJ18]: This is interesting as on the whole use of 'composting additives' is frowned on by the EA as a means of controlling odours in aerobic treatment systems. **Observation only, no comment requires**

	Technique	Description	Applicability
c	Optimise aerobic treatment	This can include: • controlling the oxygen content; • frequent maintenance of the aeration system; • use of pure oxygen; • removal of scum in tanks.	Generally applicable in case of aerobic treatment of waste.

[This BAT conclusion is based on information given in Sections 2.3.5.2, 4.5.1.2, and 4.5.2.1]

Comment [JJ19]: What does this mean? We know that in good practice composting oxygen depletion is rapid and significant after turning/mixing a batch but temporary. Control needs to take account of the 'healthy cycle' of oxygen content in the waste while it is undergoing aerobic treatment. **Observation, no member comment required.**

Comment [EN20]: Suggest text change to 'controlling the oxygen content typically present in the waste being treated' or 'supplying adequate oxygen to sustain predominantly aerobic conditions in the waste being treated'. **Comment for Bref team**

BAT 10. In order to prevent or, where that is not practicable, to reduce diffuse emissions to air, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a.	Limit the number of potential diffuse emissions sources	This includes: • appropriate design of piping layout (e.g. minimising pipe run length, reducing the number of flanges and valves, using welded fittings and pipes); • favouring the use of pressure transfer (e.g. gravity) rather than pumps; • limiting the drop height of material.	The design of piping layout is only applicable to new plants.
b.	Select and use high integrity equipment	This includes: • valves with double packing seals or equally efficient equipment; • high-integrity gaskets (such as spiral wound ring joints) for critical applications; • pumps/compressors/agitators fitted with mechanical seals instead of packing; • magnetically driven pumps/compressors/agitators.	Generally applicable.
c.	Select appropriate materials for equipment	This includes: • appropriate selection of construction material to avoid corrosion; • lining or coating of equipment and painting of pipes with corrosion inhibitors to prevent corrosion.	
d.	Ensure containment, collection and treatment of diffuse emissions	This includes: • storing and handling waste and material that may generate diffuse emissions in enclosed equipment or buildings; • collecting and directing the emissions to an appropriate abatement system (see Section 6.6.1); • dampening waste that can generate diffuse dust emissions with water.	
e.	Use semipermeable membrane covers	Active composting heaps are located in positively aerated plants covered with semipermeable membranes and sealed closed.	Only applicable to aerobic treatment of waste.

Comment [JJ21]: It is Unclear whether this applies to any outdoor phase of a composting process (i.e. not done within a building, tunnel or covered clamp) and any outdoor phase of post-AD composting of digested fibre. Is it also required if the active composting heaps are enclosed within a building? What if the composting heaps are located in negatively aerated plants – semipermeable membrane covers would represent excessive cost and practical challenge compared with the small influence they would have on diffuse pollution. **ORG to discuss issue with relevant BAT committee for clarification**

	Technique	Description	Applicability
f.	Limit potential generation of odour, dust and bioaerosols by considering meteorological conditions in the operation of the plant	This includes: • Monitoring weather conditions and wind direction and taking those conditions into account when undertaking major outdoor process activities. • Avoiding formation or turning of windrows or piles on windy days. • Undertaking screening and shredding when the wind speed is low or the wind direction is away from sensitive receptors. • Orientating windrows considering the direction of the prevailing wind. The smallest possible area of composting mass is exposed to the prevailing winds, to avoid 'stripping' of the windrow surface, and preferably at the lowest elevation within the overall site layout.	Only applicable to aerobic treatment of waste, when techniques (d) and (e) are not used.
g.	Maintenance and cleaning	This includes: • ensuring access to potentially leaky equipment; • regularly controlling protective equipment such as lamellar curtains, fast-action doors; • regularly cleaning halls, conveyor bands, etc.	Generally applicable.
h.	Set up and implement a leak detection and repair (LDAR) programme	See the description of the technique in Section 6.6.1	Only applicable to plants that contain a large number of piping components (e.g. valves) and that process a significant amount of lighter hydrocarbons.

[This BAT conclusion is based on information given in Sections 2.3.5.3, 2.3.5.4, 4.5.1.2, 4.5.2.2, and 4.5.2.3]

BAT 11. In order to prevent emissions to air from flares, BAT is to use flaring only for safety reasons or for non-routine operating conditions (e.g. start-ups, shutdowns) by using both of the techniques given below.

	Technique	Description	Applicability
a.	Correct plant design	This includes the provision of a gas recovery system with sufficient capacity and the use of high-integrity relief valves.	Generally applicable to new plants. Gas recovery system may be retrofitted in existing plants.
b.	Plant management	This includes balancing the gas system and using advanced process control.	Generally applicable.

[This BAT conclusion is based on information given in Section 2.3.5.5]

Comment [EN23]: Text here should include 'outdoor' before 'windrow'.

Comment [EN24]:

Comment [EN25]: Text here should include 'outdoor' before 'screening'.

Comment [EN26]: Text here should include 'outdoor' before 'windrow'.

Comment [JJ22]: These considerations would be routinely followed by operators hence the relevance of having a weather station on sites (that treat any biodegradable waste outdoors) to measure wind strength and direction. **Members, please indicate if you see this as being problematic.**

Comment [JJ27]: Assume this is normal practice. Are there any other techniques which should be included in addition to the ones shown? **Members please comment**

BAT 12. In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use both of the techniques given below.

Comment [JJ28]: As above. Members Please comment if there are other techniques which should be included in the list below.

	Technique	Description	Applicability
a.	Correct design of flaring devices	Optimisation of height, pressure, assistance by steam, air or gas, type of flare tips (either enclosed or shielded), etc., aimed to enable smokeless and reliable operation and to ensure the efficient combustion of excess gases.	Applicable to new flares. In existing plants, applicability may be restricted due to e.g. maintenance time availability during the turnaround of the plant.
b.	Monitoring and recording as part of flare management	Continuous monitoring of gas sent to flaring, measurements of gas flow and estimations of other parameters (e.g. composition of gas flow, heat content, ratio of assistance, velocity, purge gas flow rate, pollutant emissions (e.g. NO_X, CO, hydrocarbons, noise)). The recording of flaring events usually includes the estimated/measured flare gas composition, the estimated/measured flare gas quantity and the duration of operation. The recording allows for the quantification of emissions and the potential prevention of future flaring events.	Generally applicable.

[This BAT conclusions are based on information given in Section 2.3.5.5]

6.1.3 Emissions to water

BAT 13. In order to reduce water usage and to prevent or, where that is not practicable, to reduce the discharge of pollutants to water from waste treatment, BAT is to use all of the techniques given below.

Comment [JJ29]: As part of their existing permit condition some of the techniques below will be in operation already such as dirty/clean water separation. **Members, please indicate whether any of the actions below are impractical or unachievable in your opinion stating the reasons why.**

	Technique	Description	Applicability
a	Water-saving action plan and water audits	A water-saving plan includes: • flow diagrams and water mass balance, • establishment of water efficiency objectives, • implementation of water optimisation techniques (e.g. water pinch techniques, minimising use of washing and cleaning water). Water audits are carried out with the aim of increasing the reliability of the control and abatement performance of pollutants, reducing water usage, and preventing water contamination.	Generally applicable.
b	Segregation of different water streams in the water and drainage systems	Each water stream (e.g. road water, run-off water, process water) is collected and treated separately, depending on the pollution content. Uncontaminated water is reused as much as possible in the substitution of fresh water. Drainages from incompatible wastes are not mixed.	Generally applicable to new plants. Applicable to existing plants within the constraints given by the configuration of the water circuits.
c	Maximise internal water recycling	Increase the number and/or capacity of water recycling systems.	Water recycling may be limited by the content of impurities in the water.

[This BAT conclusion is based on information given in Section 2.3.7]

BAT 14. In order to prevent or, where that is not practicable, to reduce emissions to water, BAT is to use the technique given below.

	Technique	Description
a	Integrated waste water management and treatment strategy	The integrated strategy is based on the inventory of waste water streams (see BAT 2), and considers the following principles: • segregation of waste water streams depending on the pollution load and the combination of techniques of the treatment process (see Section 6.6.2); • reduction of the remaining pollutants (e.g. organics) after the physico-chemical treatment, by means of e.g. activated sludge system; • reduction of remaining contamination with finishing techniques (post-treatment techniques such as: coagulation and flocculation, sedimentation, filtration, flotation); • in the case of indirect discharge, the level of emission of the remaining pollutants does not have a negative impact on the downstream WWTP and this plant can adequately deal with those remaining pollutants.

[This BAT conclusion is based on information given in Section 2.3.6.7]

BAT 15. In order to reduce emissions to water, BAT is to treat waste water before discharge to the environment with an appropriate combination of techniques given below.

	Technique [1]	Typical pollutants targeted	Applicability
Preliminary and primary treatment, e.g.			
a	Equalisation	All pollutants	Generally applicable.
b	Neutralisation	Acids, alkalis	
c	Physical separation, e.g. screens, sieves, grit separators, grease separators or primary settlement tanks	Suspended solids, oil/grease	
Physico-chemical treatment, e.g.			
d	Adsorption	Organics, inorganics	Generally applicable.
e	Distillation/rectification	Organics	
f	Chemical precipitation	Metals, phosphorus	
g	Chemical oxidation	Nitrite, cyanide	
h	Chemical reduction	Chromium (VI)	
i	Ion exchange process	Metals	
j	Stripping	Hydrogen sulphide (H_2S), ammonia (NH_3), adsordable organically bound halogens (AOX), hydrocarbons	
Biological treatment, e.g.			
k	Activated sludge process	Biodegradable organic compounds	Generally applicable.
l	Membrane bioreactor		
Nitrogen removal			
m	Nitrification/denitrification	Total nitrogen, ammonia	Not applicable when the final treatment does not include a biological treatment.
Solids removal, e.g.			
n	Coagulation and flocculation	Suspended solids	Generally applicable.
o	Sedimentation		
p	Filtration (e.g. sand filtration, microfiltration, ultrafiltration)		
q	Flotation		
[1] The descriptions of the techniques are given in Section 6.6.2.			

[This BAT conclusion is based on information given in Sections 2.3.6.1 to 2.3.6.7]

Table 6.3: BAT-associated emission levels (BAT-AELs) for direct discharge to a receiving water body

Parameter		BAT-AEL (Monthly average) ([1])	Waste treatment process
Total organic carbon (TOC) ([2])		10–40 mg/l	• Mechanical treatment of waste • Biological treatment of waste • Physico-chemical treatment waste
Chemical oxygen demand (COD) ([2])		30–120 mg/l	
Total suspended solids (TSS)		5–35 mg/l	
Hydrocarbon oil index (HOI)		0.5–5 mg/l	• Mechanical treatment in shredder of metal waste • Re-refining of waste oil • Physico-chemical treatment of waste with calorific value
Total nitrogen (Total N)		5–30 mg/l ([3])	• Biological treatment of waste • Re-refining of waste oil • Physico-chemical and/or biological treatment of water-based liquid waste
Total phosphorus (Total P)		0.3–3 mg/l	
Phenol index		0.05–0.2 mg/l	• Re-refining of waste oil • Physico-chemical treatment of waste with calorific value • Physico-chemical and/or biological treatment of water-based liquid waste
Metals and metalloids ([4])	Arsenic (expressed as As)	0.01–0.05 mg/l	• Mechanical treatment in shredder of metal waste • Mechanical biological treatment of waste • Re-refining of waste oil • Physico-chemical and/or biological treatment of water-based liquid waste • Water washing of excavated contaminated soil
	Cadmium (expressed as Cd)	0.01–0.05 mg/l	
	Chromium (expressed as Cr)	0.01–0.05 mg/l	
	Nickel (expressed as Ni)	0.05–0.5 mg/l	
	Lead (expressed as Pb)	0.05–0.1 mg/l	
	Copper (expressed as Cu)	0.05–0.2 mg/l	
	Mercury (expressed as Hg)	0.001–0.01 mg/l	
	Zinc (expressed as Zn)	0.1–0.5 mg/l	

([1]) The averaging period may be adapted when the monitoring frequency is reduced (see footnote ([1]) of Table **6.1**
([2]) Either the BAT-AELs for COD or the BAT-AELs for TOC apply. TOC monitoring is the preferred option because it does not rely on the use of very toxic compounds.
([3]) The upper end of the range may be up to 40 mg/l for Total N if the abatement efficiency is ≥ 70 % as a monthly average (considering all of the waste water treatment steps carried out).
([4]) The BAT-AELs may not apply when the substance concerned is not present in the waste to be treated.

The associated monitoring is given in BAT 3

Comment [JJ30]: **Members, please indicate for the highlighted parameters if the Associated Emissions Levels shown are within your current tolerances if you already measure them.** I am aware of some sites that treat their run-off water through reed beds prior to it exiting to a watercourse. If this applies to you do you have a current discharge consent limit level set?

Table 6.4: BAT-associated emission levels (BAT-AELs) for indirect discharge to a receiving water body

Parameter		BAT-AEL (Monthly average) ([1])	Waste treatment process
Hydrocarbon oil index (HOI)		0.5–5 mg/l	• Mechanical treatment in shredder of metal waste • Re-refining of waste oil • Physico-chemical treatment of waste with calorific value
Metals and metalloids ([2])	Arsenic (expressed as As)	0.01–0.05 mg/l	• Mechanical treatment in shredder of metal waste • Mechanical biological treatment of waste • Re-refining of waste oil • Physico-chemical and/or biological treatment of water-based liquid waste • Water washing of excavated contaminated soil
	Cadmium (expressed as Cd)	0.01–0.05 mg/l	
	Chromium (expressed as Cr)	0.01–0.05 mg/l	
	Nickel (expressed as Ni)	0.05–0.5 mg/l	
	Lead (expressed as Pb)	0.05–0.1 mg/l	
	Copper (expressed as Cu)	0.05–0.2 mg/l	
	Mercury (expressed as Hg)	0.001–0.01 mg/l	
	Zinc (expressed as Zn)	0.1–0.5 mg/l	

([1]) The averaging period may be adapted when the monitoring frequency is reduced (see footnote ([1]) of Table **6.1**).
([2]) The BAT-AELs may not apply when the substance concerned is not present in the waste to be treated.

The associated monitoring is given in BAT 3

6.1.4 Consumption of raw materials and chemicals

BAT 16. In order to reduce the raw material and chemical consumption of waste treatment, BAT is to use the technique given below.

	Technique	Description	Applicability
a	Use of waste instead of raw materials for waste treatment operations	Waste is used instead of raw materials for the treatment of other wastes by substituting chemicals or raw materials (e.g. APC residues as a replacement for hydrated lime in the neutralisation of waste acid).	Some applicability limitations derive from the presence of impurities in the waste that substitutes the raw material. Another limitation is the compatibility of the waste to be used as raw material with the wastes to be treated (see BAT 2).

[This BAT conclusion is based on information given in Section 2.3.8]

6.1.5 Energy efficiency

BAT 17. In order to use energy efficiently in waste treatment, BAT is to use all of the techniques given below.

Technique		Description
a	Set up and implement an energy efficiency plan	An energy efficiency plan entails defining and calculating the specific energy consumption of the activity (or activities), setting key performance indicators on an annual basis (e.g. MWh/tonne of waste processed) and planning the periodic improvement targets and related actions.
b	Establish a detailed energy balance	A detailed energy balance provides a breakdown of the energy consumption and generation (including exportation) by the type of source (i.e. electricity, gas, conventional liquid fuels, conventional solid fuels, and waste). This involves: (i) reporting the energy consumption information in terms of delivered energy; (ii) reporting the energy exported from the installation; (iii) providing energy flow information (for example, Sankey diagrams or energy balances) showing how the energy is used throughout the process.

[This BAT conclusion is based on information given in Sections 2.3.9.1 and 2.3.9.2]

Comment [JJ31]: This seems onerous. I am uncertain how these will be assessed and by whom? **Members, please comment on these requirements.**

6.1.6 Noise and vibrations

BAT 18. In order to prevent or, where that is not practicable, to reduce noise and vibration emissions, BAT is to set up, implement and regularly review a noise and vibration management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements:

I. a protocol containing appropriate actions and timelines;
II. a protocol for conducting noise and vibration monitoring;
III. a protocol for response to identified noise and vibration events;
IV. 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.

Comment [JJ32]: I assume as part of permit conditions these will already be covered. **Members, please comment if this is not the case.**

Applicability

The applicability is restricted to cases where noise or vibration nuisance can be expected or has been substantiated.

[This BAT conclusion is based on information given in Sections 2.3.10.1 and 3.1.3.2.1]

BAT 19. 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	Increasing the distance between the emitter and the receiver and using buildings as noise screens.	For existing plants, the relocation of equipment may be restricted by a lack of space or excessive costs.
b	Operational measures	This includes: i. improved inspection and maintenance of equipment; ii. closing of doors and windows of enclosed areas, if possible; iii. equipment operation by experienced staff; iv. avoidance of noisy activities at night, if possible; v. provisions for noise control during maintenance activities.	Generally applicable.
c	Low-noise equipment	This includes compressors, pumps and flares.	
d	Noise and vibration control equipment	This includes: i. noise-reducers; ii. equipment insulation; iii. enclosure of noisy equipment; iv. soundproofing of buildings.	Applicability may be restricted due to space requirements (for existing plants).
e	Noise abatement	Inserting obstacles between emitters and receivers (e.g. protection walls, embankments and buildings).	For existing plants, the insertion of obstacles may be restricted by a lack of space. For mechanical treatment in shredders of metal wastes, it is applicable within the constraints imposed by the possible deflagration in shredders.

[This BAT conclusion is based on information given in Sections 2.3.10.2 and 3.1.3.2.2]

6.1.7 Emissions to soil and groundwater

BAT 20. In order to prevent emissions to soil and groundwater from waste treatment, BAT is to use all of the techniques given below.

Comment [JJ33]: As above this will be routinely covered by the existing permit conditions. **Members, please comment if you do not concur with this view.**

	Technique	Description
a	Sealed surface and retention volume	The surface of the whole waste treatment area (e.g. waste reception, handling, storage, treatment and dispatch areas) is sealed (e.g. concrete base). Each storage tank for liquids is located in a liquid-proof retention area.
b	Adequate drainage infrastructure	The waste treatment area is connected to a drainage infrastructure. Run-off water falling on the treatment area is collected in the drainage infrastructure along with tanker washings, occasional spillages, drum washings, etc. and returned to the waste treatment plant or collected in an interceptor. Interceptors with an overflow to sewer have automatic monitoring systems, such as pH checks, which can trigger the shutting down of the overflow.
c	Design and maintenance provisions to allow detection and repair of leaks	Vessels and pipework are located above ground or a secondary containment of underground components is put in place. Regular monitoring for potential leakages is carried out. When underground pipework is used, it is equipped with suitable inspection channels.
d	Security basin	A basin used to collect surges that may be contaminated, e.g. firefighting water. The discharge of waste water from this basin to a receiving water body or to the sewer is only possible after further appropriate measures are taken (e.g. control, treat, reuse).

[This BAT conclusion is based on information given in Sections 2.3.11 and 2.3.14]

6.1.8 Management of residues

BAT 21. In order to reduce the amount of residues generated during waste treatment, BAT is to use the technique given below.

	Technique	Description
a	Maximise the reuse of packaging	Packaging (drums, containers, IBCs, palettes, etc.) is reused for containing waste, when it is in good working order and sufficiently clean, on the basis of a compatibility check between the two substances contained (first and second use). If necessary, packaging is sent for appropriate treatment (e.g. reconditioning, cleaning, and washing).

[This BAT conclusion is based on information given in Section 2.3.12]

6.1.9 Emissions from accidents and incidents

BAT 22. In order to prevent or limit the environmental consequences of accidents and incidents, BAT is to use all of the techniques given below.

Comment [JJ34]: As above this will be routinely covered by the existing permit conditions. **Members, please comment** .

	Technique	Description
a	Management of accidental emissions	Procedures are established and technical provisions are in place to manage accidental emissions such as spillages, firefighting water, or emissions from safety valves.
b	Event registration and assessment system	This includes: • A log/diary to record all incidents, near-misses, changes to procedures, abnormal events, and the findings of maintenance inspections. Leaks, spills and accidents can be recorded in the site diary. • Procedures to identify, respond to and learn from such incidents.
c	Protection measures	These include: • security measures to protect the plant against malevolent acts which could have environmental impacts; • fire and explosion protection system, containing prevention and detection equipment, and extinction equipment; • instrumentation and control equipment is accessible and maintained in emergency situations.

[This BAT conclusion is based on information given in Section 2.3.13.1]

6.1.10 Waste storage and handling

BAT 23. In order to prevent or, where that is not practicable, to reduce the environmental risk of the storage of waste, BAT is to use all of the techniques given below.

	Technique	Description	Applicability
a	Storage location	Storage is located away from watercourses	Generally applicable to new plants.
b	Storage design	This includes: • Measures are taken to prevent, detect and mitigate overflows from tanks and vessels. Vessel overflow pipes are directed to a contained drainage system (i.e. the relevant bund area or another vessel). • Tanks and vessels are isolable.	
c	Storage capacity	Measures are taken to avoid storage/accumulation of waste, such as: • a waste acceptance (see BAT 2) plan is used; • the maximum waste storage capacity is clearly established and communicated; • the quantity of waste stored is regularly verified against the maximum allowed storage capacity.	Generally applicable.
d	Safe storage operation	This includes: • equipment used for loading, unloading and storing waste is clearly documented and labelled; • waste segregation measures are taken (see BAT 2); • substances known to be sensitive to heat, light, air, water, etc. are protected from such ambient conditions; • containers and drums are fit for purpose and stored securely.	
e	Storage of laboratory smalls	Dedicated area is used for sorting and repacking laboratory smalls	Only applicable for plants storing laboratory smalls.

[This BAT conclusion is based on information given in Section 2.3.13.2]

Comment [EN35]: Change to 'isolatable'.

BAT 24. In order to reduce the environmental risk associated with the handling of waste, BAT is to use the following technique.

	Technique	Description
a	Handling systems and procedures	This includes: • handling of waste is carried out by qualified and trained staff; • transfers and discharges of waste are duly documented and validated prior to execution; • measures are taken to ensure couplings are correctly fitted when connecting hoses or pipes; • measures are taken to prevent, detect and mitigate spills; • technical and, if relevant, construction precautions are taken to protect human health and the environment when mixing or blending wastes, depending on the composition and consistency of the wastes to be mixed or blended (e.g. vacuuming dust-like wastes).

[This BAT conclusion is based on information given in Section 2.3.13.3]

6.2 BAT conclusions for mechanical treatment of waste

Unless otherwise stated, the BAT conclusions presented in this section apply to the mechanical treatment of waste, in addition to the general BAT conclusions of Section 6.1.

6.2.1 General BAT conclusions for mechanical treatment of waste

6.2.1.1 Emissions to air

BAT 25. In order to reduce dust emissions to air, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a	Cyclone	See Section 6.6.1.	Generally applicable.
b	Wet scrubber	See Section 6.6.1.	Not applicable to mechanical treatment of mercury-containing equipment.
c	Fabric filter	See Section 6.6.1.	Not applicable to exhaust air ducts directly connected to the mill for mechanical treatment in shredders of metal waste.
d	Water injection into the shredder mill	The shredded material is made damp by injecting water into the mill. The amount of water is regulated in relation to the amount of energy consumed by the main motor. The airflow that contains residual dust is directed to cyclone(s) and/or wet (venturi) scrubber	Only applicable to mechanical treatment in shredders of metal waste in combination with techniques (a) and/or (b), within the constraints imposed by local meteorological conditions (low temperature).

Table 6.5: BAT-associated emission levels (BAT-AELs) for dust emissions to air from mechanical treatment of waste

Parameter	Unit	BAT-AEL (Average of samples obtained during one year)
Dust	mg/Nm^3	<2–5 ([1])

([1]) When a fabric filter cannot be applied in shredders of metal waste for safety reasons, the higher end of the range is 10 mg/Nm^3.

The associated monitoring is given in BAT 4.

[This BAT conclusion is based on information given in Sections 3.1.3.1.1, 3.2.3.1.2 and 3.3.4.1.1]

Comment [JJ36]: Not clear whether this is also applicable to dust emissions from machines used in MBT, composting and AD facilities. **Authors to clarify**.

Comment [JJ37]: Are these acceptable levels and are they currently measured in this way in the UK? **Members, please comment.**

6.2.2 BAT conclusions for the mechanical treatment in shredders of metal waste

6.2.2.1 General environmental performance

BAT 26. In order to improve the general environmental performance, and to reduce the risk of accidents and incidents, BAT is to use the technique given below.

	Technique	Description
a	Acceptance of waste input	This includes: a. set up and implement a detailed baled material inspection procedure before shredding; b. remove and return to the owner dangerous items (e.g. gas cylinders, dirty drums, EoLVs with dangerous parts) left in the waste stream by mistake; c. reception and acceptance of drums and containers only when accompanied by a certificate of cleanliness.

[This BAT conclusion is based on information given in Sections 2.3.2 and 3.1.3.1.2.3]

6.2.2.2 Diffuse emissions to air and deflagrations

BAT 27. In order to prevent or reduce deflagrations and related diffuse emissions, BAT is to use both of the techniques given below.

	Technique	Description
a	To use pressure relief equipment	In order to control deflagrations, pressure relief dampers are installed. They are equipped with rubber flaps preventing diffuse emissions in normal operation.
b	To set and implement procedures to reduce the number of deflagrations	This includes: • a protocol containing appropriate actions and timelines; • a protocol for conducting deflagration monitoring; • a protocol for response to deflagration incidents; • a deflagration reduction programme designed to identify the source(s), and to implement elimination and/or reduction measures (e.g. inspection of waste input and management of prohibited materials); • a review of historical deflagration incidents and remedies and the dissemination of deflagration knowledge.

[This BAT conclusion is based on information given in Sections 3.1.3.1.2.2 and 3.1.3.1.2.3]

6.2.2.3 Energy efficiency

BAT 28. In order to use energy efficiently, BAT is to use the technique given below.

	Technique	Description
a	Mill feeding regulation	Reduction of peak energy consumption and power losses and avoidance of unwanted shutdowns of the mill, by regulating the feed to ensure that the shredder load and rotor speed are as constant as possible.

[This BAT conclusion is based on information given in Section 3.1.3.3.1]

6.2.3 BAT conclusions for mechanical treatment in shredders of equipment containing VFCs or VHCs

6.2.3.1 Emissions to air

BAT 29. In order to prevent or, where that is not practicable, to reduce VOC emissions to air, BAT is to use one of the techniques given below.

	Technique	Description
a	Removal of VOC from the shredding area and treatment by cryogenic condensation	Waste gas containing VFCs/VHCs is extracted from the shredding area, and inert gas (e.g. N_2) is blown in to reduce the O_2 concentration below 4 vol-%. This waste gas is then sent to a cryogenic condensation unit where it is liquefied (see description in Section 6.6.1). The liquid gas is stored in tanks for further treatment. The inert gas is recovered and reused to reduce the O_2 concentration.
b	Removal of VOC from the shredding area and treatment by adsorption	Waste gas containing VFCs/VHCs is extracted from the shredding area and led into adsorption filters (see description in Section 6.6.1). The spent activated carbon is regenerated by means of heated air pumped into the filter to evaporate trapped VFCs/ VHCs. After the filter, the gas is compressed and cooled in order to liquefy the VFCs/VHCs. The liquefied gas is then stored in tanks. The emitted gas is usually led back into the adsorbing filter in order to recover any residual VFCs/VHCs.

Table 6.6: BAT-associated emission levels (BAT-AELs) for TVOC emissions to air from mechanical treatment in shredders of equipment containing VFCs or VHCs

Parameter	Unit	BAT-AEL (Average of samples obtained during one year)
TVOC	mg/Nm^3	2–15

The associated monitoring is given in BAT 4.

[This BAT conclusion is based on information given in Section 3.2.3.1.1]

6.2.4 BAT conclusions for the mechanical treatment of mercury-containing equipment

6.2.4.1 Emissions to air

BAT 30. In order to prevent or, where that is not practicable, to reduce mercury emissions to air, BAT is to use the technique given below.

	Technique	Description
a	Collection at source followed by abatement and surveillance of mercury emissions	This includes all of the following: • Processes used to treat mercury-containing equipment are enclosed, under negative pressure and connected to a Local Exhaust Ventilation system (LEV). • Extracted air from the processes is treated by dedusting techniques such as cyclones, fabric filters, HEPA filters as well as activated carbon filters (see Section 6.6.1). • Treated air is either released outside the buildings or recycled. • The air flow from the Local Exhaust Ventilation system (LEV) and mercury concentration in the LEV extracted air are monitored to enable the assessment of the effectiveness of the LEV performance. • Mercury levels in ambient air are measured regularly around the processes to detect potential mercury leaks.

[This BAT conclusion is based on information given in Section 5.8.2.3.1]

Table 6.7: BAT-associated emission levels (BAT-AELs) for mercury emissions to air from mechanical treatment of mercury-containing waste

Parameter	Unit	BAT-AEL (Average of samples obtained during one year)
Mercury (Hg)	µg/Nm^3	2–7

The associated monitoring is given in BAT 4.

6.3 BAT conclusions for biological treatment of waste

Unless otherwise stated, the BAT conclusions presented in this section apply to biological treatment of waste, in addition to the general BAT mentioned in Section 6.1.

6.3.1 General BAT conclusions for biological treatment of waste

Comment [JJ38]: Members please comment on any of the text below that you think is relevant.

6.3.1.1 General environmental performance

BAT 31. In order to minimise the generation of odorous emissions and to improve the general environmental performance, BAT is to use the technique given below.

	Technique	Description
a	Selection of waste input	Pre-acceptance, acceptance, and sorting of the waste input to enable an appropriate nutrient balance, and to prevent toxic compounds (i.e. toxic in terms of reducing biological activity) entering the biological systems.

[This BAT conclusion is based on information given in Section 4.5.1.1]

6.3.1.2 Emissions to air

BAT 32. In order to reduce channelled emissions of odorous substances, H_2S and NH_3, BAT is to use a biofilter (See Section 6.6.1).

Table 6.8: BAT-AELs (BAT-AELs) for channelled NH_3 and H_2S emissions to air from the biological treatment of waste

Parameter	Unit	BAT-AEL (Average of samples obtained during one year)
NH_3	mg/Nm^3	0.1–10
H_2S	mg/Nm^3	0.1–1 ([1])
([1]) The lower end of the range is associated with the use of a wet scrubber before the biofilter		

Comment [JJ39]: Members, are these AELs acceptable? Please comment

The associated monitoring is given in BAT 4.

[This BAT conclusion is based on information given in Section 4.5.1.4]

6.3.1.3 Emissions to water and water usage

BAT 33. In order to minimise generation of leachate and the volume of waste water, as well as to avoid contamination of ground or surface waters and to reduce water usage, BAT is to use the technique given below.

Comment [JJ40]: As before, this will be routinely covered by the existing permit conditions. Members, please comment if you do not agree with this view.

Technique	Description	Applicability
Water and leachate management	Segregation of leachate seeping from compost piles and windrows, surface water arising from roads, and uncontaminated run-off water from buildings.	Generally applicable to new plants. Applicable to existing plants within the constraints imposed by the configuration of the water circuit.
	When relevant in aerobic processes, the ceiling of the biological degradation hall is thermally insulated in order to minimise the generation of condensate.	Generally applicable.

Comment [JG41]: For tunnel systems with fabric roofs this could be an issue?

	Recycling process waters (e.g. from dewatering of liquid digestate in anaerobic processes) or muddy residues, or using as much as possible alternative sources of water, e.g. condensed water, rinsing water, run-off water, within the process.	The recycling of water into the process is limited by potential contents of impurities (heavy metals, salts, pathogens, etc.).
	Adjusting the moisture content of the waste to its water-holding capacity and therefore minimising the generation of leachate.	Generally applicable.

[This BAT conclusion is based on information given in Section 4.5.1.5]

6.3.2 BAT conclusions for aerobic treatment of waste

6.3.2.1 General environmental performance

BAT 34. In order to reduce emissions to air and to improve the general environmental performance, BAT is to monitor the process and to control the key process parameters as mentioned below.

	Technique	Description	Applicability
a	Aerobic process monitoring	Proper monitoring and control of key process parameters, including: • waste input characteristics (e.g. C:N ratio, particle size); • water content; • air diffusion through the waste; • temperature.	Monitoring of the water content is not applicable to enclosed processes when health and/or safety issues have been identified.

[This BAT conclusion is based on information given in Section 4.5.2.1]

6.3.3 BAT conclusions for anaerobic treatment of waste

6.3.3.1 General environmental performance

BAT 35. In order to reduce emissions to air and to improve the general environmental performance, BAT is to monitor the process and to control the key process parameters as mentioned below.

	Technique	Description
a	Anaerobic process monitoring	Implement a monitoring system, manual and/or automatic, to: • ensure a stable reactor operation; • minimise operational difficulties, such as foaming, which may lead to odour problems; • provide sufficient early warning of system failures which may lead to loss of containment and, potentially, explosions. This includes monitoring of key process parameters, such as: • pH and alkalinity; • temperature and temperature distribution; • hydraulic loading rate; • organic loading rate including total solids and volatile solids fractions;

Comment [EN42]: Observation only: Such practice won't reduce the generation of leachate! The reference in section 4.5.1.5 is specific to aerobic composting and refers to 'adjusting the initial moisture content of the feedstock to adapt it as much as possible to the water-holding capacity'. Such moisture content is unlikely to be compatible with aeration needs as the decomposition process progresses. Authors need to decide whether this aspect of BAT is supposed to apply to anaerobic as well as aerobic treatment (it sits in 6.3.1 which is about general BAT conclusions for biological treatment of waste). If it just applies to aerobic treatment, authors please consider changing the text to: 'Adjusting the moisture content of the waste, taking account of oxygen as well as moisture needs of microbes at each relevant stage of biological treatment. Process management should also aim to minimise the generation of leachate but not to such an extent that biological activity is compromised and/or other emissions become significantly increased'.

Comment [JJ43]: Waste type and quality is checked under PAS but not necessarily C:N and certainly not diffusion rates.Inclusion of C:N should not be a problem though because it's just named as an example. The operator should be able to justify a different waste input characteristic and monitor that instead, if he/she knows that would be more technically appropriate given his/her process and the biodegradable waste type. PAS doesn't specifically require monitoring of air diffusion through the waste.... This aspect of BAT might not yet be included in all permits. **Members, please pass comment on this section**

Comment [JJ44]: **Members, please comment if you disagree with any of the proposed process monitoring. Supporting reasons would be helpful if you suggest alternative methods.**

		• concentration of volatile fatty acids (VFA); • ammonia; • C:N ratio; • gas generation and composition; • gas pressure; • H2S concentration in the gas; • liquid and foam levels.

[This BAT conclusion is based on information given in Section 4.5.3.1]

6.3.4 BAT conclusions for mechanical biological treatment (MBT) of waste

The BAT conclusions for aerobic and anaerobic treatment of waste apply, when relevant, to mechanical biological treatment of waste.

6.3.4.1 Emissions to air

BAT 36. In order to prevent or, where that is not practicable, to reduce emissions to air, BAT is to use all of the techniques given below.

Comment [JJ45]: Please comment on this if you operate an MBT plant and provide specific objections or concerns.

	Technique	Description	Applicability
a	Separate collection of air flows	Splitting of the total volume flow that is to be treated into heavily polluted exhaust air and lightly polluted exhaust air.	Generally applicable to new plants. Applicable to existing plants within the constraints imposed by the configuration of the air circuits.
b	Partial reuse of exhaust air in the biological process	Use the exhausted air from the delivery waste input area (such as low bunkers and underground bunkers with or without mechanical treatment), or reuse the treated air as air supply (process air) for biological degradation. It may be necessary to condense the water vapour contained in the exhausted air before reuse. In this case, cooling is necessary, and the condensed water is treated before discharge.	

[This BAT conclusion is based on information given in Section 4.5.4.1]

BAT 37. In order to reduce dust and VOC emissions to air, BAT is to use one or a combination of the techniques given below, in addition to BAT 32.

Comment [JJ46]: ONLY Relevant to MBT, as above.

	Technique	Description
a	Fabric filter	See Section 6.6.1.
b	Wet scrubber	
c	Thermal oxidation	

[This BAT conclusion is based on information given in Section 4.5.4.1]

Table 6.9: BAT-associated emission levels (BAT-AELs) for dust and VOC emissions to air from mechanical biological treatment of waste

Parameter	Unit	BAT-AEL (Average of samples obtained during one year)
Dust	mg/Nm^3	2–5
TVOC	mg/Nm^3	5–15

The associated monitoring is given in BAT 4

Comment [JJ47]: Are these AELs achievable? **Members, please comment.**

6.4 BAT conclusions for physico-chemical treatment of waste

Unless stated otherwise, the BAT conclusions presented in this section apply to physico-chemical treatment of waste, in addition to the general BAT mentioned in Section 6.1

6.4.1 BAT conclusions for the physico-chemical treatment of solid and/or pasty waste

6.4.1.1 General environmental performance

BAT 38. In order to improve the general environmental performance, BAT is to use the technique given below.

	Technique	Description	Applicability
a	Acceptance procedures of solid and/or pasty waste to be treated	Acceptance procedures include controlling: • the waste input content of e.g.: o organics, o solid cyanides, o oxidising agents, o mercury; • H_2 emissions when fly ashes or air pollution control (APC) residues are mixed with water.	Controlling H_2 emissions is only applicable when the fly ashes or APC residues contain carbonate.

[This BAT conclusion is based on information given in Section 5.1.4.1.1]

6.4.1.2 Emissions to air

BAT 39. In order to reduce dust, VOC and NH_3 emissions to air, BAT is to use one or a combination of the techniques given below.

	Technique	Description
	Fabric filter	See Section 6.6.1.
	Wet scrubber	
	Biofilter	
	Adsorption	

[This BAT conclusion is based on information given in Section 5.1.4.2]

Table 6.10: BAT-associated emission levels (BAT-AELs) for dust, VOC, and NH_3 emissions to air from physico-chemical treatment of solid and/or pasty waste

Parameter	Unit	BAT-AEL (Average of samples obtained during one year)
Dust	mg/Nm^3	2–5
TVOC		2–15
NH_3		0.1–5

The associated monitoring is given in BAT 4

6.4.2 BAT conclusions for the re-refining of waste oil

6.4.2.1 General environmental performance

BAT 40. In order to improve the general environmental performance of waste oil re-refining, BAT is to use both of the techniques given below.

	Technique	Description
a	Set up and implement acceptance procedures	Acceptance procedures include controlling the waste input content in chlorinated compounds (e.g. solvents or PCBs).
b	Residue management	Using the residues as heater feed in a heater equipped with wet scrubber to generate energy for the plant.

[This BAT conclusion is based on information given in Sections 5.2.3.1 and 5.2.3.3]

6.4.2.2 Emissions to air

BAT 41. In order to reduce VOC emissions to air, BAT is to use the technique given below.

	Technique	Description
a	Thermal oxidation	See Section 6.6.1 . The waste gas may also be fed into a process furnace or a boiler.

[This BAT conclusion is based on information given in Section 5.2.3.4]

Table 6.11: BAT-associated emission levels (BAT-AELs) for VOC emissions to air from re-refining of waste oil

Parameter	Unit	BAT-AEL (Average of samples obtained during one year)
TVOC	mg/Nm^3	5–15

The associated monitoring is given in BAT 4

6.4.2.3 Emissions to water and water usage

BAT 42. In order to reduce water usage and emissions to water, BAT is to use one or both of the techniques given below.

	Technique	Description
a	Waste water pretreatment	This includes pretreatment of waste water such as evaporation and steam stripping (see description in Section 6.6.2) prior to the WWTP.
b	Reuse of water	Reusing the cleaned waste water as cooling water after appropriate treatment.

[This BAT conclusion is based on information given in Section 5.2.3.2]

6.4.3 BAT conclusions for the physico-chemical treatment of waste with calorific value

6.4.3.1 Emissions to air

BAT 43. In order to reduce VOC emissions to air from plants performing physico-chemical treatment of liquid and semi-liquid waste with calorific value, BAT is to use one or a combination of the techniques given below.

	Technique	Description
•	Adsorption	See Section 6.6.1
•	Thermal oxidation	
•	Wet scrubber	

[This BAT conclusion is based on information given in Section 5.3.4.1]

Table 6.12: BAT-associated emission levels (BAT-AELs) for VOC emissions to air from plants performing physico-chemical treatment of liquid and semi-liquid waste with calorific value

Parameter	Unit	BAT-AEL (Average of samples obtained during one year)
TVOC	mg/Nm^3	5-15

The associated monitoring is given in BAT 4.

6.4.4 BAT conclusions for the regeneration of spent solvents

6.4.4.1 General environmental performance

BAT 44. In order to improve the general environmental performance of regeneration of spent solvents, BAT is to use the technique given below.

	Technique	Description
a	Recover solvents from distillation residues	Vacuum drying and other drying techniques are used to evaporate the residues from the distillation columns and recover the solvents.

[This BAT conclusion is based on information given in Section 5.4.3.1]

6.4.4.2 Emissions to air

BAT 45. In order to prevent or, where that is not practicable, to reduce VOC emissions to air, BAT is to use a suitable combination of the techniques given below.

	Technique	Description	Applicability
a	Recirculation of waste gas from solvent regeneration process in steam boiler	Collected waste gas is cooled and chilled to condense and partially separate solvents. This waste gas with remaining solvents is fed to the steam boiler supplying the plant. If the steam boiler is not in operation or the waste gas volume would exceed the steam boiler air demand, the pretreated waste gas is treated by activated carbon filters before release.	Not applicable to the treatment of halogenated solvent wastes, in order to avoid generating and emitting PCBs.
b	Condensation/ Cryogenic condensation	See Section 6.6.1 for the description of the techniques. Adequate control of condenser parameters is essential to minimise VOC emissions from the condenser vents. Condenser (cooling) failure results in an automatic process shutdown.	Generally applicable.
c	Activated carbon adsorption	See Section 6.6.1 for the description of the technique.	There may be limitations to the applicability of the technique due to safety reasons (e.g. activated carbon beds tend to self-ignite when loaded with ketones).
d	Wet scrubber	See Section 6.6.1 for the description of the technique.	Generally applicable.

[This BAT conclusion is based on information given in Sections 5.4.3.3 and 5.4.3.4]

Table 6.13: BAT-associated emission levels (BAT-AELs) for VOC emissions to air from plants performing regeneration of spent solvents

Parameter	Unit	BAT-AEL (Average of samples obtained during one year)
TVOC	kg per tonne of spent solvent treated	0.02-0.36

The associated monitoring is given in BAT 4

BAT 46. In order to reduce the generation of waste water and to reduce water usage, BAT is to use the technique given below.

	Technique	Description
a	Liquid ring pumps with high boiling point liquids	Solvent vapours generated by the distillation process carried out under vacuum are absorbed into liquids with high boiling points. The liquid used is alternately cooled and heated in a continuous process. When becoming hot, the condensed and soluble solvents are desorbed and the liquid ring fluid is returned to the vacuum pump for the next reuse. Desorbed solvents are condensed and recovered.

[This BAT conclusion is based on information given in Section 5.4.3.5]

6.4.5 BAT conclusions for the thermal treatment of spent activated carbon, waste catalysts and excavated contaminated soil

6.4.5.1 General environmental performance

BAT 47. In order to improve the general environmental performance of the thermal treatment of spent activated carbon, waste catalysts and excavated contaminated soil, BAT is to use all of the techniques given below.

	Technique	Description	Applicability
a	Heat recovery	This involves gas/gas heat exchangers to allow the preheating of combustion air and waste gas reheating. There may also be a waste heat boiler used for the generation of steam, which is also used in the reactivation of the carbon.	Generally applicable.
b	Reduction of waste gas to be treated	Use an indirectly fired kiln to avoid contact between the kiln content and waste gases generated by the burner(s).	Indirectly fired kilns are normally constructed with a metal tube and applicability may be restricted due to corrosion problems that may appear during treatment of some activated carbons used in industrial applications.
c	Primary measures for reducing particulate and acid gas emissions	This includes: - control of furnace temperature, turning rate of the rotary furnace, fuel type; - design of the regenerator and associated ducting and equipment to operate under a reduced pressure, in order to prevent the escape of regenerator gases into the air; - use of a sealed furnace.	Design measure are generally only applicable to new plants.

[This BAT conclusion is based on information given in Sections 5.5.3.1 and 5.5.4.1]

6.4.5.2 Emissions to air

BAT 48. In order to reduce emissions to air, BAT is to use one or a combination of the techniques given below.

	Technique	Description
a	Thermal oxidation ([1])	See Section 6.6.1.
b	Cyclone	
c	Wet scrubber ([2])	
d	ESP	
e	Fabric filter ([3])	
f	Adsorption	
g	Condensation of waste gas	

([1]) Thermal oxidation is carried out with a minimum temperature of 1100 °C and two-second residence time for the regeneration of activated carbons used in industrial applications where refractory halogenated or other thermally resistant substances are likely to be present. In the case of activated carbon used for potable water- and food-grade applications, an afterburner with a minimum heating temperature of 850 °C and two-second residence time is sufficient (see Section Section 6.6.1).
([2]) Caustic or soda ash scrubbing solutions are used to neutralise acid gases for thermal treatment of activated carbon used in industrial applications.
([3]) Cooling the waste gas prior to a fabric filter is an important technique as it provides temperature protection for the filter and allows a wider choice of fabric.

[This BAT conclusion is based on information given in Sections 5.5.3.1 and 5.5.4.1]

6.4.6 BAT conclusions for the water washing of excavated contaminated soil

6.4.6.1 Emissions to air

BAT 49. In order to reduce dust and VOC emissions to air, BAT is to use one or a combination of the techniques given below.

	Technique	Description
a	Wet scrubber	See Section Section 6.6.1.
b	Fabric filter	
c	Adsorption	

[This BAT conclusion is based on information given in Section 5.6.3.2.2]

6.4.7 BAT conclusions for the decontamination of equipment containing POPs

6.4.7.1 General environmental performance

BAT 50. In order to improve the general environmental performance of PCB decontamination, BAT is to apply all of the techniques given below.

	Technique	Description
a	Design measures to prevent dispersion of PCBs from the storage and treatment areas	• Dedicated storm and run-off water collection system. • Resin coating applied to the whole concrete floor of the storage and treatment areas.
b	Implementation of staff access rules to prevent dispersion of contamination	• Accesses to storage and treatment areas are locked. • Special qualification is required to access the area where the waste or polluted equipment is handled. • Separate 'clean' and 'dirty' cloakrooms to put on/take off individual protective outfit.
c	Prevention of liquid PCB dispersion during the decontamination process	• External surfaces of the contaminated electrical equipment are cleaned with anionic liquid. • Pumping the PCB oil out of the electrical equipment with a pump or under vacuum instead of gravity emptying. • Procedures are defined and used for filling, emptying and (dis)connecting the vacuum vessel. • Long period of dripping (at least 12 hours) to avoid any PCB drop during further treatment operations, after the separation of the core from the casing of an electrical transformer.
d	Control of emissions to air	• The ambient air of the decontamination workshop is treated on activated carbon filters. • The exhaust of the vacuum pump mentioned in technique (c) above is connected to an end-of-pipe abatement system (e.g. a high temperature kiln or activated carbon filters).
e	Management of waste treatment residues	• Porous contaminated parts of the electrical transformer (wood and paper) are fed into a high temperature kiln ($\geq$ 1100 °C). • Destruction of the PCBs in the oils (dechlorination, hydrogenation, solvated electron processes).

[This BAT conclusion is based on information given in Section 5.8.1.3.1]

6.4.7.2 Emissions to air

BAT 51. When solvent washing is used for PCB decontamination, and in order to prevent or, where that is not practicable, to reduce VOC emissions to air and to recover solvent, BAT is to use all of the techniques given below.

	Technique	Description
a	Recovery of solvent	Solvent emissions are collected and distilled in order to recover solvent and reuse it in the process
b	Control of VOC emissions	Airstreams over the whole working zone are collected (see BAT 10) and treated by activated carbon adsorption (for airstreams with low pollutant content) or thermal oxidation (see Section 6.6.1) for gas streams with high pollutant contents (typically solvent vents, etc.).

[This BAT conclusion is based on information given in Section 5.8.1.3.2]

6.5 BAT conclusions for the physico-chemical and/or biological treatment of water-based liquid waste

Unless stated otherwise, the BAT conclusions presented in this section apply to physico-chemical and/or biological treatment of water-based liquid waste, in addition to the general BAT mentioned in Section 6.1

Comment [JJ48]: This could apply to AD. Members please comment please.

6.5.1 Emissions to air

BAT 52. In order to reduce HCl, NH_3 and VOC channelled emissions to air, BAT is to use one or a combination of the techniques given below.

	Technique	Description
a	Adsorption	See Section 6.6.1
b	Wet scrubber	
c	Biofilter	

[This BAT conclusion is based on information given in Section 5.7.3.1]

Table 6.14: BAT-associated emission levels (BAT-AELs) for HCl, NH_3, and VOC emissions to air from physico-chemical and/or biological treatment of water-based liquid waste

Parameter	Unit	BAT-AEL (Average of samples obtained during one year)
Hydrogen chloride (HCl)	mg/Nm^3	1–3 ([1])
Ammonia (NH_3)		0.1–5
TVOC		3–20

([1]) This BAT-AEL does not apply if only biological treatment is carried out.

Comment [JJ49]: Members please comment on these AELs. Are they achievable. Please indicate if you measure these currently.

The associated monitoring is given in BAT 4.

6.6 Descriptions of techniques

6.6.1 Emissions to air

Technique	Typical pollutant(s) abated	Description
Absolute filter	Dust	In absolute filters (e.g. HEPA = high-efficiency particle air filter, ULPA = ultra-low penetration air filter), the filter medium is paper or matted glass fibre with a high packing density. The waste gas stream is passed through the filter medium, where particulate matter is collected.
Adsorption	Mercury, volatile organic compounds, hydrogen sulphide odorous compounds	Adsorption is a heterogeneous reaction in which gas molecules are retained on a solid or liquid surface (adsorbent also referred to as a molecular sieve) that prefers specific compounds to others and thus removes them from effluent streams. When the surface has adsorbed as much as it can, the adsorbed content is desorbed as part of the regeneration of the adsorbent. When desorbed, the contaminants are usually at a higher concentration and can either be recovered or disposed of. The most common adsorbent is granular activated carbon.
Fabric filter	Dust	Bag or fabric filters are constructed from porous woven or felted fabric through which gases are passed to remove particles. The use of a bag filter requires the selection of a fabric suitable for the characteristics of the waste gas and the maximum operating temperature.
Biofilter	Ammonia, hydrogen sulphide, volatile organic compounds, odorous compounds	The waste gas stream is passed through a bed of organic material (such as peat, heather, compost, root, tree bark, compost, softwood and different kinds of combinations) or some inert material (such as clay, activated carbon, and polyurethane), where it is biologically oxidised by naturally occurring microorganisms into carbon dioxide, water, inorganic salts and biomass.
Condensation and cryogenic condensation	Volatile organic compounds	Condensation is a technique that eliminates solvent vapours from a waste gas stream by reducing its temperature below its dew point. Cryogenic condensation can cope with all VOCs and volatile inorganic pollutants, irrespective of their individual vapour pressures. The low temperatures applied allow for very high condensation efficiencies in such a way that it is well-suited as a final VOC emission control technique.
Cyclone	Dust	Cyclone filters are used to remove heavier particulates, which 'fall out' as the waste gases are forced into a rotating motion before they leave the separator again. Cyclones are used to control particulate material, primarily PM_{10}. There are high-efficiency cyclones (e.g. multi-cyclones) designed to be effective even for $PM_{2.5}$.

Comment [EN50]: Compost is mentioned twice here. Suggest changing the latter to 'oversize woody material by-product of composting' **Observation only**

Electrostatic precipitator (ESP)	Dust	Electrostatic precipitators operate such that particles are charged and separated under the influence of an electrical field. Electrostatic precipitators are capable of operating under 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.
Leak detection and repair (LDAR) programme	Volatile organic compounds	A structured approach to reduce fugitive VOC emissions by detection and subsequent repair or replacement of leaking components. Currently, sniffing (described by EN 15446) and optical gas imaging methods are available for the identification of leaks. **Sniffing method**: The first step is the detection using hand-held VOC analysers measuring the concentration adjacent to the equipment (e.g. by using flame ionisation or photo-ionisation). The second step consists of enclosing the component in an impermeable bag to carry out a direct measurement at the source of the emission. This second step is sometimes replaced by mathematical correlation curves derived from statistical results obtained from a large number of previous measurements made on similar components. **Optical gas imaging methods**: Optical imaging uses small lightweight hand-held cameras which enable the visualisation of gas leaks in real time, so that they appear as 'smoke' on a video recorder together with the normal image of the component concerned, to easily and rapidly locate significant VOC leaks. Active systems produce an image with a back-scattered infrared laser light reflected on the component and its surroundings. Passive systems are based on the natural infrared radiation of the equipment and its surroundings.
Thermal oxidation	Volatile organic compounds	The oxidation of combustible gases and odorants in a waste gas stream by heating the mixture of contaminants with air or oxygen to above its auto-ignition point in a combustion chamber and maintaining it at a high temperature long enough to complete its combustion to carbon dioxide and water.

VOC diffuse emissions monitoring	Volatile organic compounds	Sniffing and optical gas imaging methods are described under leak detection and repair programme. Full screening and quantification of emissions from the installation can be undertaken with an appropriate combination of complementary methods, e.g. Solar occultation flux (SOF) or Differential absorption LIDAR (DIAL) campaigns. These results can be used for trend evaluation in time, cross-checking and updating/validation of the ongoing LDAR programme. Solar occultation flux (SOF): The technique is based on the recording and spectrometric Fourier Transform analysis of a broadband infrared or ultraviolet/visible sunlight spectrum along a given geographical itinerary, crossing the wind direction and cutting through VOC plumes. Differential absorption LIDAR (DIAL): This is a laser-based technique using differential absorption LIDAR (light detection and ranging), which is the optical analogue of radio wave-based RADAR. The technique relies on the back-scattering of laser beam pulses by atmospheric aerosols, and the analysis of the spectral properties of the returned light collected with a telescope.
Wet scrubbing	Dust, volatile organic compounds, gaseous acids (basic scrubber), gaseous alkalis (acid scrubber)	Wet scrubbing (or absorption) is a mass transfer between a soluble gas and a solvent – often water – in contact with each other. Physical scrubbing is preferred for chemical recovery, whereas chemical scrubbing is restricted to removing and abating gaseous compounds. Physico-chemical scrubbing takes an intermediate position. The component is dissolved in the absorbing liquid and involved in a reversible chemical reaction, which enables the recovery of the gaseous component.

6.6.2 Emissions to water

Technique	Typical pollutant(s) targeted	Description
Equalisation	All pollutants	Balancing of flows and pollutant loads by using tanks or other management techniques.
Neutralisation	Acids, alkalis	The adjustment of the pH of waste water to a neutral level (approximately 7) by the addition of chemicals. Sodium hydroxide (NaOH) or calcium hydroxide ($Ca(OH)_2$) may be used to increase the pH; whereas, sulphuric acid (H_2SO_4), hydrochloric acid (HCl) or carbon dioxide (CO_2) may be used to decrease the pH. The precipitation of some substances may occur during neutralisation.
Oil-water separation	Oil/grease	The separation of oil and water and subsequent oil removal by gravity separation of free oil, using separation equipment or emulsion breaking, using emulsion breaking chemicals such as metal salts, mineral acids, adsorbents and organic polymers.
Coagulation and flocculation	Suspended solids	Coagulation and flocculation are used to separate suspended solids from waste water and are often carried out in successive steps. Coagulation is carried out by adding coagulants with charges opposite to those of the suspended solids. Flocculation is carried out by adding polymers, so that collisions of microfloc particles cause them to bond to produce larger flocs.
Electrocoagulation		The release of coagulants in the waste water to be treated is realised by electrolytically dissolving an electrode (i.e. anode, normally made of Fe or Al). When the electrode is dissolved, gas is released (i.e. O_2, H_2) which results in a flotation effect. If necessary, a (support) flocculant can be added to improve the flotation yield.
Filtration		The separation of solids from waste water by passing them through a porous medium, e.g. sand filtration, microfiltration and ultrafiltration.
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.
Membrane filtration		Microfiltration (MF) and ultrafiltration (UF) are membrane processes that retain and concentrate on one side of the membrane substances such as suspended particles and colloidal particles contained in waste waters.
Sedimentation		The separation of suspended particles by gravitational settling.

Adsorption	Soluble non-biodegradable or inhibitory contaminants, e.g. organics	Adsorption is the transfer of soluble substances (solutes) from the waste water phase to the surface of solid, highly porous particles (the adsorbent). The adsorbent most commonly used is activated carbon.
Distillation/rectification	Soluble non-biodegradable or inhibitory contaminants	Distillation or rectification is the separation of waste water from its contaminants by transferring them into the vapour phase. The enriched vapour phase is condensed afterwards.
Chemical precipitation	Soluble non-biodegradable or inhibitory contaminants, e.g. metals, phosphorus	The conversion of dissolved pollutants into insoluble compounds by adding chemical precipitants. The solid precipitates formed are subsequently separated by sedimentation, air flotation or filtration. If necessary, this may be followed by microfiltration or ultrafiltration.
Chemical oxidation	Soluble non-biodegradable or inhibitory contaminants, e.g. nitrite, cyanide	Chemical oxidation is the conversion of pollutants by chemical oxidising agents other than oxygen/air, or by bacteria, into similar but less harmful or hazardous compounds and/or to short-chained and more easily degradable or biodegradable organic components. Chemical oxidation is also used to degrade organic compounds causing odour, taste, colour and for disinfection purposes
Chemical reduction	Soluble non-biodegradable or inhibitory contaminants, e.g. chromium (VI)	Chemical reduction is the conversion of pollutants by chemical reducing agents into similar but less harmful or hazardous compounds
Evaporation	Soluble non-biodegradable or inhibitory contaminants	Evaporation of waste water is a distillation process where water forms the vapour phase, leaving the concentrate as bottom residue to be disposed of. The volatile steam is collected in a condenser and the condensed water is, if needed after subsequent treatment, recycled.
Ion exchange process	Soluble non-biodegradable or inhibitory contaminants, e.g. metals	Ion exchange is the removal of undesired or hazardous ionic constituents of waste water and their replacement by more acceptable ions from an ion exchange resin, where they are temporarily retained and afterwards released into a regeneration or backwashing liquid.
Nanofiltration and reverse osmosis	Soluble non-biodegradable or inhibitory contaminants	A membrane process is the permeation of a liquid through a membrane, to be segregated into permeate that passes through the membrane and concentrate that is retained. The driving force of this process is the pressure difference across the membrane. Nanofiltration and reverse osmosis membranes can hold back all particles down to the size of organic molecules and even ions.

Stripping	Soluble non-biodegradable or inhibitory contaminants, e.g. hydrogen sulphide (H_2S), ammonia (NH_3), adsordable organically bound halogens (AOX), hydrocarbons	The removal of volatile pollutants from waste water by bringing them into contact with a high volume flow of a gas current in order to transfer them to the gas phase. The pollutants are removed from the stripping gas in a downstream treatment such as condensation and phase separation, and may potentially be reused.
Activated sludge process	Biodegradable organic compounds	The biological oxidation of dissolved organic substances with oxygen using the metabolism of microorganisms. In the presence of dissolved oxygen (injected as air or pure oxygen), the organic components are transformed into carbon dioxide, water or other metabolites and biomass (i.e. the activated sludge). The microorganisms are maintained in suspension in the waste water and the whole mixture is mechanically aerated. The activated sludge mixture is sent to a separation facility from where the sludge is recycled to the aeration tank.
Anaerobic treatment		Anaerobic waste water treatment converts the organic content of waste water, with the help of microorganisms and without entry of air, to a variety of products such as methane, carbon dioxide, sulphide, etc.
Membrane bioreactor		A combination of activated sludge treatment and membrane filtration. Two variants are used: a) an external recirculation loop between the activated sludge tank and the membrane module; and b) immersion of the membrane module into the aerated activated sludge tank, where the effluent is filtered through a hollow fibre membrane, the biomass remaining in the tank.
Nitrification/denitrification	Total nitrogen, ammonia	A two-step process that is typically incorporated into biological waste water treatment plants. The first step is the aerobic nitrification where microorganisms oxidise ammonium (NH_4^+) to the intermediate nitrite (NO_2^-), which is then further oxidised to nitrate (NO_3^-). In the subsequent anoxic denitrification step, microorganisms chemically reduce nitrate to nitrogen gas.

6.6.3 Sorting techniques

Technique	Description
Air classification	Air classification (or air separation, or aeraulic separation) is a process of approximate sizing of dry mixtures of different particle sizes into groups or grades at cut points ranging from 10 mesh to sub-mesh sizes. Air classifiers (also called windshifters) complement screens in applications requiring cut points below commercial screen sizes, and supplement sieves and screens for coarser cuts where the special advantages of air classification warrant it.
All metal separator	Metals (ferrous and non-ferrous) are sorted by means of a detection coil in which the magnetic field is influenced by metal particles, linked to a processor that controls the air jet for ejecting the materials that have been detected.
Ballistic separation	Materials are separated in a ballistic separator, or ballistic sieve, composed of a series of parallel paddles, with orbital motion, arranged with a variable angle with respect to the horizontal. The materials fed into the ballistic separator, having different physical characteristics (weight, shape, surface…), assume different trajectories following the orbital movement of the paddles.
Electromagnetic separation of non-ferrous metals	Non-ferrous metals are sorted by means of eddy current separators. An eddy current is induced by a series of rare earth magnetic or ceramic rotors at the head of a conveyor that spins at high speed independently of the conveyor. This process induces temporary magnetic forces in non-magnetic metals of the same polarity as the rotor, causing the metals to be repelled away and then separated from the other feedstock.
Manual separation	Material is manually separated by means of visual examination by staff on a picking line to either selectively remove a target material from a general waste stream, or to remove contamination from an output stream to increase purity. This technique generally targets recyclables (glass, plastic, etc.) and any contaminants, hazardous materials and oversize materials such as WEEE. Manual separation takes place within a covered cabin isolated from the rest of the mechanical treatment hall, to limit staff exposure, e.g. to dust and particulates, vehicle movements, and vibration.
Magnetic separation	Ferrous metals are sorted by means of a magnet which attracts ferrous metal materials. This can be carried out, for example, by an overband magnetic separator, or a magnetic drum.
Near infrared spectroscopy (NIS)	Materials are sorted by means of a near infrared sensor which scans the whole width of the belt conveyor and transmits the characteristic spectra of the different materials to a data processor which controls an air jet for ejecting the materials that have been detected.
Sink-float tanks	Solid materials are separated into two flows by exploiting the different material densities..
Size separation	Materials are sorted according to their particle size. This can be carried out by drum screens, linear and circular oscillating screens, flip-flop screens, flat screens, tumbler screens and moving grates.
Vibration table	Materials are separated according to their density and size, moving (in slurry in the case of wet tables, or wet density separators) across an inclined table, which oscillates backwards and forwards.

X-ray systems	Metal composites are sorted according to various material densities, halogen components, or organic components, with the aid of x-rays.

6.6.4 Management techniques

Accident management plan	The accident management plan is part of the EMS (see BAT 1) and identifies hazards posed by the plant and the associated risks and defines measures to address these risks. It considers the inventory of substances present or likely to be present which could have environmental consequences if they escape.
Residue management plan	A residue management plan is a set of measures aiming to 1) minimise the generation of residues arising from the treatment of waste; 2) optimise the reuse or regeneration of the residues; and 3) ensure the proper disposal of internal residues or waste

7 EMERGING TECHNIQUES

From ex-Chapter 6

~~Emerging technique is understood in this document as a novel technique that has not yet been applied in any industrial sector on a commercial basis.~~
Article 3(14) of Directive 2010/75/EU defines an 'emerging technique' as a 'novel technique for an industrial activity that, if commercially developed, could provide either a higher general level of protection of the environment or at least the same level of protection of the environment and higher cost savings than existing best available techniques'. This chapter contains those techniques that may appear in the near future and that may be applicable to the waste treatment sector.

Note for TWG: this chapter does not contain those emerging techniques which aim only to improve a given waste treatment process (for instance to improve productivity or output quality) without leading to a higher general level of protection of the environment for the process concerned (for instance reduction of emissions or residues from the process).

[2, Concawe 1996] [21, Viscolube 2002] [17, Eklund, B.: Thompson, P.: Inglis, A.: Wheeless, W., et al. 1997] [25, UK Department of the Environment 1991] [58, VDI and Dechema 2002] [62, Rogut, S. 2003] [70, Greenpeace 1998] [78, Eucopro 2003] [88, UBA Germany 2003] [94, Magistrelli et al. 2002] [98, WT TWG 2004][100, WT TWG 2004] [102, UNEP 2004]

7.1 General techniques

7.1.1 Combination of vibration and air separation

TWG, please confirm the technique described below is still an emerging technique

Description
The basic principle is an air separation table, based on a combination of vibration and air sorting technology.

Technical description
The heavy fractions are conveyed upwards by the vibration and discharged at the upper end of the separation table. Lighter components are suspended by the air introduced through the screen mat and float downwards to the other end of the system (see Figure 7.1).

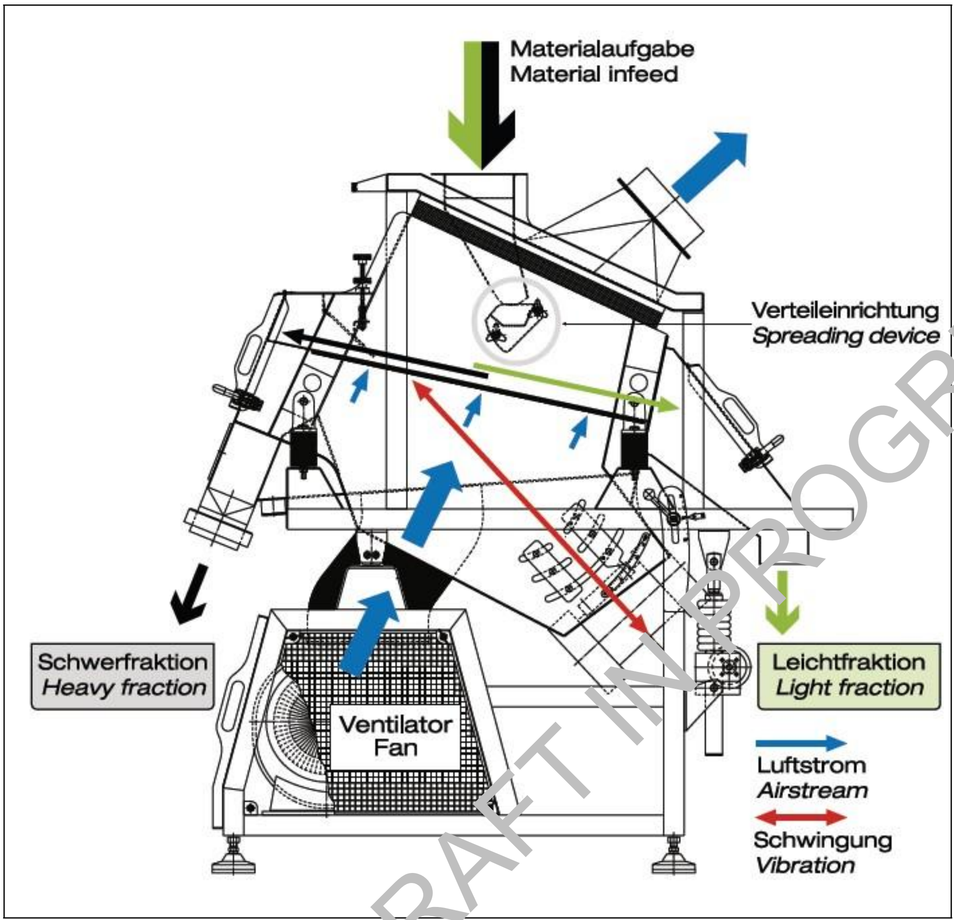

Figure 7.1: Basic principle of the separation table, based on a combination of vibration and air technology

The basic principle is already applied for several applications:

- copper enrichment of dust resulting from shredding of cables (10–250 µm);
- extraction of chromite for reuse in the foundry industry.

Adaptation of the described technique for the following applications is considered an emerging technique:

- separation of rubber and plastic in windows fractions;
- demetallisation of wood chips;
- mechanical treatment of dusts (de-stoning, demetallisation);
- separation of dry household waste (heavy/light density separation);
- separation of construction waste (heavy/light density separation);
- separation of minerals (primary resources) (heavy/light density separation.

Achieved environmental benefits
No water usage.

Potential performance compared to existing best available techniques
The new applications of the technique are focused (at least partially) on substituting existing wet separation techniques, like pulsating jigs or other gravity separation processes. The major benefit is that there is no water usage and therefore no need for waste water and sludge treatment.

Preliminary cost-benefit estimate
Costs of the technique are derived from existing installations performing copper enrichment and are described in Table 7.1

Table 7.1: Economics associated with the combination of vibration and air sorting

Type of costs	Costs	Comments
Investment/capital costs:		
Machine	EUR 40 000	
Auxiliary equipment (screening, conveying)	EUR 150 000	
Dedusting	EUR 25 000	Only for specific applications, often not necessary because a central dedusting unit is installed.
Operation and maintenance costs (labour utilities, consumables, etc.)		
Energy	5 kW	
Labour	1 supervisor	
Maintenance	EUR 5 000 per year	
Revenues, avoided costs and benefits	No or reduced cost for waste water and sludge treatment compared to wet density separation techniques	
Cost-determining factors	Feed rate, material preparation, particle sizes, difference of gravity	

Technical considerations related to applicability
Table 7.2 shows the application limits of the technique.

Table 7.2: Application limits and restrictions of the combination of vibration and air sorting

Parameter	Limit/Restriction
Particle size	< 10 mm
Throughput	< 8 m^3/h (depending on material)
Humidity of material	< 1 %

Cross-media effects
TWG, please provide information

Driving force for implementation
No investment needed for treatment of waste water and sludges.

Indication of when the technique might become commercially available'
As described, some forms of the application already exist. New applications like separation of
window fractions or wood chips may be applied with minimum modifications within one year at the maximum. Applications for household waste and mineral processing with higher feed rates per machine are at the R&D stage and should be launched in 2016/2017.

Example plants
Austrian reference plants for the described technique are SMK and Schaufler (copper recovery from cable scrap). One prototype exists for wood chips and one for window treatment. Another prototype exists for the separation of rubber and sand for the recycling of stable floors.

Reference literature
[156]