# Key Environmental Issues (KEI) and BAT-associated emission levels (BAT-AEls) for Composting

## General framework conditions

Within the BAT Conclusions (C5) and when this derives from the data collection, emission limit values (ELVs) for identified KEI shall be defined in order to ensure that, under normal operating conditions, emissions do not exceed BAT-associated emission levels (BAT-AELs). Once defined, derogation from BAT-AELs is only allowed in specific and justified cases, i.e.

* It must be demonstrated that costs are disproportionately higher than benefits due to local/installation-specific situations; and
* Member States have to report to the public/the Commission on the use of such derogations.

### Here some important definitions:

* Where **emission and consumption levels “associated with best available techniques”** are presented, this is to be understood as meaning that those levels represent the environmental performance that could be anticipated as a result of the application, in this sector, of the techniques described, bearing in mind the balance of costs and advantages inherent within the definition of BAT.
* However, they are neither emission nor consumption limit values and should not be understood as such. In some cases, it may be technically possible to achieve better emission or consumption levels but due to the costs involved or cross- media considerations, they are not considered to be appropriate as BAT for the sector as a whole. However, such levels may be considered to be justified in more specific cases where there are special driving forces…
* …The concept of **‘levels associated with BAT’** described above is to be distinguished from the term **‘achievable level’** used elsewhere in this document. Where a level is described as ‘achievable’ using a particular technique or combination of techniques, this should be understood to mean that the level may be expected to be achieved over a substantial period of time in a well maintained and operated installation or process using those techniques…
* BAT AELs are not ‘statistically based’, however they can be ‘statistically-informed’ (provided the necessary data is available); **BAT-AELs are derived based on** **expert judgement => empirical determination**

Another source is the data collection through the questionnaire. Existing emission limits as set by national regulations should be used rather as a reference relative to achievable (best) performance.

Also other than normal operating conditions (ONOC) must be taken into account.

**Conclusions for biological treatment based on data collection**

The detailed analyses of the results of the questionnaires (see document Federal Environment Agency Austria) for biological treatment showed the following shortcomings in order to serve as a trustworthy source for identifying Key Environmental Indicators (KEI) as well as BAT-AEL and ELV respectively:

* A wide range of performance data
* No clear and sufficiently detailed description of processing/operational framework conditions behind the reported emission data (e.g. composition of feedstock, specific measurement method applied, timing of measurement)
* Wide range of limit setting

As regards ***emissions to water*** the current observation is that indirect discharge of any waste water from biological treatment facilities for source separated biowaste is sufficiently addressed by national regulations based on the EU Water Framework Directive. However in case of discharge of waste water that has been treated in an own waste water treatment plant the BAT associated emissions levels as defined in the CWW BREF, Chapter 4.3.1. Table 4.8. have to be complied with.



In case of ***emissions to air*** for the debate on the relevance of KEI it is of general importance to distinguish between channelled emissions from an abatement system (e.g. from reception building, Biofilter, RTO etc.) and diffuse emissions which have to be related to the complete treatment facility, in specific to all open/ outdoor facilities and processes.

In case of *Outdoor composting*, diffuse emissions are the only type of emission produced, hence making focus on general design (location, orientation of stored and processed biowaste etc.) as well as operation (e.g. material selection and manipulation and timing) is key to reduce emissions to air by means of a set of effective operational measures. This has been extensively elaborated in C4 and is an important element of BAT-C.

Three different aspects must be considered as regards the type of impact of a KEI and its importance for functioning of the process and techniques:

* Environment protection objectives like e.g. GHG emissions, potential impacts on ground and surface water: general environmental indicator (G)
* Nuisance related emissions: perception in the vicinity of the plant / complaints and specific health protection, such as odour, dust: local perception /nuisance precaution (L)
* Indicators for a best available performance of the plant: key process parameter to be monitored (P)

Following this, the Tables below addressing the monitoring requirements for identified KEIs are divided into

1. Parameters to be monitored aiming at the optimised process management (P)
2. Parameters with direct relevance for emission control (L/G)

## Outdoor Composting

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| **Criteria related predominantly to PROCESS management and optimisation** |
| **Parameter** | **Type of Impact** | **Rationale** | **Monitoring** | **Orientation values** |
| **Temperature** | P | Besides the indication of the thermal hygienisation process (>55/60/65 °C over a certain time priod as defined by national legislation), regular temperature monitoring indicates the achieved progress of biological transformation (decomposition and stabilization into humus compounds)Prolonged periods of sustained temperatures > 70 °C may lead to the formation of odorous compounds. | **Timing:**During hygienisation and intensive, high temperature phase (> 55 °C) according to national legislation.**Methods:*** Calibrated continuous sen­sors with cable or radio trans­mission or data logger
* Calibrated analogue or digital sensors for discontinuous measure­ments.
 | **Hygienisation**: >55/60/65 °C**Reducing odours and improving biological complexation**: <70 °C |
| **H2O** | P | Sufficient humidity is an important criterion for a continuous and optimised microbial decomposition and humus formation process. It has to be adjusted according to the rotting stage. Over supply as well as deficiency may lead to anaerobic conditions, related odour problems and increased dust and bioaerosol formastion respectively. | **Timing:**At every turning date, during intensive decomposition pahse (> 45°C) at least every 2nd day), during maturation at least weekly **Method:**Visual control, squeeze test or moisture probes. Assessment results should be verified at regular, stated intervals by comparison with quantitative results (% mass/mass) oven drying method. | Depending on composition (water holding capacity) of the material mix:**Intensive decomposition phase (> ca. 45 °C):** 45 – 65 % f.m.**Maturation phase phase (< ca. 45 °C):** 30 – 50 % f.m. |
| **O2 / CO2** | P | Proper proportions of O2 and CO2 in the pore air of composting material are reliable indicators for a sufficient oxidative decomposition process.  | **Timing:**In composting windrows during main/high temperature rotting phase, in case of repeated and systematic odour complaints, in regular intervals, at least once per 2 working days. **Method:**Digital or analogue test probes;Test points shall be evenly distributed over the composting pile, in core/centre of the cros-section of the compost windrow/pile. | **Orientation values in pore air:**O2: > 2%CO2: < 21 to 23% |
| **Criteria related to PROCESS management and optimisation as well as to possible nuisance impacts in the vicinity of the composting plant**  |
| **Odours** | Odour is an important process related parameter indicating process management is performed in a way that the biological decomposition specifically in the primary first intensive composting phase provides optimised aerobic conditions for the microbiological transformation (Feedstock composition, humidity, windrow size, turning frequency, C:N ratio, bulking/structure materials, porosity, optional: aeration). However, a possible impact of diffuse odorous emissions releases depend very much on the location of the composting plant, i.e. dispersion dynamics relative to sensitive receptors in the vicinity of the installation, potentially causing nuisance and complaints. Hence, odour has to be addressed as mainly a LOCAL issue to be managed – at first instance by means of adjustment of operational criteria (see C5). Measuring odour e.g. by means of Olfactometry does not give reliable results in case of pure diffuse (not channelled) sources. Hence, the following measures are proposed: * For *new plants*
	+ BAT is to define the location to limit impacts on environment
	+ BAT is in the design stage of the plant to apply a dispersion modelling in order to assess the potential strength and time distribution of odour events that are likely to cause considerable nuisance to nearby sensitive receptors. Status quo and other potential sources of odour emissions in the vicinity of the planned composting plant shall be taken into account.
* For *new plants when in operation* and *plants already in operation* when the BREF was set into force – in case of repeated, systematic complaints by the neighbourhood
	+ BAT is
		- to apply a series of techniques and manage the process in order to prevent emission problems and complaints.
		- to adopt a detailed complaints management plan
		- in case of repeated, systematic complaints by the neighbourhood
			* to implement a documented adjustment of the process management (operation) including the odour abatement techniques in place in order to reduce odour emissions which may create nuisance to sensitive receptors in the vicinity of the composting plant;
			* in case the adjustment measures failed to achieve the desired improvement and to reduce the events of complaints, to apply a dispersion modelling in order to assess the potential strength and time distribution of odour events that are likely to cause the reported nuisance to complaining sensitive receptors.
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| **Criteria related to possible nuisance or health impacts in the vicinity of the composting plant** |
| **Dust** | Dust emissions may be associated with all outdoor mechanical manipulation of organic or mineral material. Usually, depending on particle size, sedimentation takes place between 20 and 500 m. In this way fine dust shows in most topographic and local climate conditions similar dispersion behaviour as odour.* For *new plants*
	+ If the dispersion modelling carried out for potential odour emissions in the design stage of the plant predicts a low likelihood of causing considerable nuisance to nearby sensitive receptors, the magnitude of dust impacts to sensitive neighbourhood is interpreted as acceptable.
	+ BAT is to adopt a detailed complaints management plan
* For *new plants when in operation* and *plants already in operation* when the BREF was set into force, in case of repeated, systematic complaints by the neighbourhood
	+ BAT is to adopt a detailed complaints management plan
	+ BAT is to apply practical measures that reduce dust emissions on site and dispersion to surrounding areas. In case of repeated, systematic dust complaints by the neighbourhood, BAT is to apply additional operational measures to reduce dust emissions: this includes in particular the wetting of materials during turning/handling, wetting of paved surfaces, and stopping dust sensitive activities when critical wind directions/speeds occur
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## Indoor Composting

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| **Criteria related predominantly to PROCESS management and optimisation** |
| **Parameter** | **Type of Impact** | **Rationale** | **Monitoring** | **Orientation values** |
| **Temperature** | P | Besides the indication of the thermal hygienisation process (>55/60/65 °C over a certain time priod as defined by national legislation), regular temperature monitoring indicates the achieved progress of biological transformation (decomposition and stabilization into humus compounds)Prolonged periods of sustained temperatures > 70 °C may lead to the formation of odorous compounds. | **Timing:**During hygienisation and intensive, high temperature phase (> 55 °C) according to national legislation.**Methods:*** Continuous sensors with cable or radio trans­mission
 | **Hygienisation**: >55/60/65 °C**Reducing odours and improving biological complexation**: <70 °C |
| **H2O** | P | Sufficient humidity is an important criterion for a continuous and optimised microbial decomposition and humus formation process. It has to be adjusted according to the rotting stage. Over supply as well as deficiency may lead to anaerobic conditions, related odour problems and increased dust and bioaerosol formastion respectively when extracted from the closed composting unit. | **Timing:**Before loading the material into the enclosed composting reactor or hall, at every turning date and when extracted from the enclosed composting reactor or hall **Method:**Visual control, squeeze test (if feasible in case of intermediate extraction from closed vessel/reactor), moisture sensors in the composting material; optimal moisture content inside the enclosed composting unit can be maintained based on the operator’s experience; OR by calculation of the water balance (water addition / water evaporation in waste air).Assessment results should be verified at regular, stated intervals by comparison with quantitative results (% mass/mass) oven drying method. | **Intensive decomposition phase (> ca. 45 °C):** 45 – 65 % f.m.**Maturation phase phase (< ca. 45 °C):** 30 – 50 % f.m. |
| **O2 / CO2**  | P  | Proper proportions of O2 and CO2 in the pore air of composting material are reliable indicators for a sufficient oxidative decomposition process. Alternatively the CO2 concentration in the raw gas (off gas from aerated rotting reactors) can be measured | **Timing:**During main/high temperature rotting phase once / 2 working days**Method:**Digital test probes  | **Orientation values in pore air:**O2: > 2%CO2: < 21 to 23%**Orientation values in in raw gas:**O2: > 2 CO2: < 14% |
| **Criteria related to PROCESS management and optimisation as well as to possible nuisance impacts in the vicinity of the composting plant**  |
| **Odours** | L/ P | Odour is an important process related parameter indicating process management is performed in a way that the biological decomposition specifically in the primary first intensive composting phase provides optimised aerobic conditions for the microbiological transformation (key elements herein are: feedstock composition, humidity, temperature, volume of rotting batches, turning frequency, C:N ratio, pH, bulking/structure materials, porosity, aeration, existence and functioning of a wet/acid scrubber for stripping out NH3, functioning of the biofilter). However, odour emissions are restricted to waste reception, mechanical pre-treatment/ preparation for composting, intensive rotting phase at high temperatures); during maturation (at temperatures below 40/45 °C) odour emissions usually are neglectable. Abatement technology (biofilter et cetera) and the design of the plant (closed facility) ensure that odour emissions are normally prevented to the extent that they are not leading to nuisance. Activities like transport and storage of compost could lead to odour nuisance regarding indoor composting.* For *new plants*
	+ BAT is
		- in the design stage of the plant to apply a dispersion modelling in order to assess the potential strength and timely distribution of odour events that are likely to cause considerable nuisance to nearby sensitive receptors. Status quo and other potential sources of odour emissions in the vicinity of the planned composting plant shall be taken into account;
		- to adopt a detailed complaints management plan
* For *new plants when in operation* and *plants already in operation* when the BREF was set into force, in case of repeated, systematic complaints by the neighbourhood
	+ BAT is
		- to adopt a detailed complaints management plan
		- in case of repeated, systematic complaints by the neighbourhood
			* to implement a documented adjustment of the process management (operation) including the odour abatement techniques in place in order to reduce odour emissions which may create nuisance to sensitive receptors in the vicinity of the composting plant;
			* in case the adjustment measures failed to achieve the desired improvement and to reduce the events of complaints, to apply a dispersion modelling in order to assess the potential strength and time distribution of odour events that are likely to cause the reported nuisance to complaining sensitive receptors
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| **Parameter** | **Type of Impact** | **Rationale** | **Monitoring** | **Orientation values** |
|  |  | I indoor composting channeled odour emissions origin from treated waste air out lets like biofilters. The functioning of the odour abatement technique in place (e.g. biofilter) can be assessed via regular sampling and measurements of odour concentrations. | **Timing:**Once in 3 years or in case of reported odour problems (repeated, systematic com-plaints)**Method:**EN 13725: “Air Quality-Determination of Odour Concentration by Dynamic Olfactometry”; at the point of channelled emission (e.g. open or closed biofilter) | 500 to 1500 OU/m³  |
| **Criteria related to global impacts as well as possible nuisance impacts in the vicinity of the composting plant** |
| **Dust** | Dust emissions may be associated with all outdoor mechanical manipulation of organic or mineral material. Usually, depending on particle size, sedimentation takes place between 20 and 500 m. In this way fine dust shows in most topographic and local climate conditions similar dispersion behaviour as odour.* For *new plants*
	+ If the dispersion modelling carried out for potential odour emissions in the design stage of the plant predicts a low likelihood of causing considerable nuisance to nearby sensitive receptors, magnitude of dust impacts to sensitive neighbourhood is interpreted as acceptable.
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	+ BAT is to apply practical measures that reduce dust emissions on site and dispersion to surrounding areas. In case of repeated, systematic dust complaints by the neighbourhood, BAT is to apply additional operational measures to reduce dust emissions: this includes in particular the wetting of materials during turning/handling, wetting of paved surfaces, and stopping dust sensitive activities when critical wind directions/speeds occur
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| **Parameter** | **Type of Impact** | **Rationale** | **Monitoring** | **Orientation values** |
| **NH3** | L/G/P | Ammonia is partly transformed in the biofilter to nitrate, partly also into nitrous oxide and is also released as ammonium. If a certain threshold concentration is exceeded Ammonia also inhibits the function of the biofilter. Hence, overloading of the biofilter should be prevented, A regular excess of the threshold concentrations indicate the need of the installation of an acid scrubber system.  | **Timing:**According to Biofilter design and maintenance handbook ~~3 years~~ and in case of reported odour problems (repeated, systematic complaints)**Method:**Measurements in samples of the untreated exhaust gas or by means of online measurements before the biofilter.Measurements in samples of the treated gas after the biofilter | Raw gas: 10 – 50 mg/m³depending on design and capacity of the biofilterTreated gas: 5 -10 mg/m³ (optimum: < 5 mg/m³) |