How to comply with your environmental permit. Additional technical guidance for: composting and aerobic treatment sector.

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Forward: our guidance

This Sector Guidance Note is one of a series of three additional guidance notes for biowaste treatment installations and waste operations that require permits under the Environmental Permitting Regulations 2010 (EPR 2010) and The Environmental Permitting (England and Wales) Amendment) Regulations 2013. It sets out, both for operators and regulators, indicative Best Available Technique (BAT) or appropriate measures (environmental standards of operation) for the aerobic composting and thermophilic aerobic digestion (TAD) of biodegradable wastes. It specifically applies to facilities carrying out those aerobic treatment or digestion and associated activities which require an environmental permit as waste operations or listed Part A(1) Schedule 1 installation activities under the EPR 2010. Here after both installations and waste operations are referred to as facilities.

This Guidance has been produced by the Environment Agency. The guidance is supported by Natural Resources Wales (NRW), Northern Ireland Environment Agency (NIEA) and Scottish Environment Protection Agency (SEPA) - each referred to as “the Regulator” in this document. Its publication follows consultation with industry, Government departments and non-governmental organisations. This technical guidance document is targeted at composting and aerobic treatment operations.

You should use this guidance in addition to the standards and measures described in the general guidance note **‘How to comply with your Environmental Permit’ (EPR 1.00)** to demonstrate how you will meet the objectives of your permit. You may also need to consult the ‘horizontal’ guidance that gives in depth information on particular topics such as, emissions, odour or noise. They are listed in Part 3 of EPR 1.00.

The structure of this guidance

The structure and contents of this guidance have been largely informed by the findings of the “Composting and Aerobic Treatment– Literature Review (2012)”. This review identifies current established technical standards for operating and controlling environmental pollution and impacts from different types composting an aerobic treatment processes. This guidance is not a design guide, but does contain considerations for infrastructure design commissioning, process control and maintenance which we consider to be BAT. It is envisaged that this guidance will be revised within 12 months of publication or when further information becomes available.

Link to permit conditions

EPR permit conditions describe the objectives (or outcomes) that we want you to achieve. They do not normally tell you how to achieve them. These conditions give you a degree of flexibility. This guidance indicates what we consider are BAT or appropriate measures. You may need to apply other higher environmental standards of operation or appropriate measures if the objectives of your permit condition are not being met.

This note may state measures which are mandatory because they are currently required by BREF for installations or they are legislative requirements.

Industrial Emissions Directive (IED) and BAT

The IED requires you to take all appropriate measures to **prevent** or, where this is not practical, to **minimise** emissions to the environment, in particular (but not solely) through applying best available techniques (BAT).

BAT requires that the techniques and measures employed provide an appropriate level of environmental protection taking into consideration the likely costs and environmental benefits of the measures and set in the context of what can be afforded in each sector.

We cannot permit a facility where its operation would present a risk of causing significant pollution.

This technical guidance has been developed to provide indicative BAT or appropriate measures (environmental standards of operation) for both installations and waste operations. It includes the technical components, process control, and management of the activities. These will be applied unless departure (which may include stricter standards) can be justified for a particular activity. In addition it provides the benchmark levels for emissions. Departures from those benchmark levels can be justified at the site level by taking into account the technical characteristics of the process operation, its geographical location and the local environmental conditions.

If any mandatory EU emission limits or conditions are applicable, they must be met as a minimum.

Steps are required to be taken to prevent emissions - unless prevention is not practicable in which case they must be reduced. If it is economically and technically viable to reduce emissions further, or prevent them altogether, then this should be done. We are required to consider the environment as a whole and it's not to be used as a recipient of pollutants and waste which can be filled up to a given level, instead all that is practicable should be done to minimise emissions and their impact. This approach first considers what emission prevention can reasonably be achieved and then checks to ensure that the local environmental conditions are secure.

Ultimately, the process will only be permitted to operate if it does not cause significant pollution.

We encourage the development and introduction of innovative techniques that advance indicative environmental standards, i.e. techniques which have been developed on a scale which reasonably allows implementation in the sector, which are technically and economically viable and which further reduce emissions and their impact on the environment as a whole. One of the main aims of the legislation is continuous improvement in the overall environmental performance as a part of progressive sustainable development.

BAT standards are usually based on an assessment throughout the European Union of the typical costs and environmental benefits of techniques and their viability within the sector as a whole. The EU BREF for biological treatment has not yet been developed. The standards in this guidance have been developed, drawing on existing agreed industry standards and peer reviewed literature, having regard to all relevant legal considerations and following targeted consultation with industry.

Waste operations

We consider that the environmental standards of operation set out in this guidance represent appropriate measures for waste operations under the Waste Framework Directive, as well as BAT for installations under the IED. They may be applied, where necessary, in the development, delivery, operation and regulation of waste operation aerobic treatment and composting processes where pollution is a risk or where pollution is ongoing or has been occurring.

The Industrial Emissions Directive (IED) extends the scope of the Directive on Integrated Pollution Prevention and Control (IPPC) to include aerobic treatment of more than 75 tonnes of waste per day for recovery or 50 tonnes per day for disposal. This includes aerobic treatment and composting source segregated and mixed organic fractions from municipal waste. This was previously regulated as a waste operation only. Composting biodegradable waste will now fall under EPR as either an installation, if waste treatment is greater than 75 tonnes per day for recovery or 50 tonnes per day for disposal or a waste operation, if less than these thresholds.

This guidance applies where aerobic treatment and composting techniques for source segregated wastes forms part of the treatment process. These include composting and aerobic biodrying when used as part of the process in Mechanical Biological Treatment (MBT) and Mechanical Heat Treatment (MHT) where aerobic treatment forms the basis of treatment of organic fraction of the waste. It also includes thermophilic aerobic digestion (TAD). It does not include other non-aerobic biowaste treatments such as anaerobic digestion. This guidance is directly applicable to aerobic biowaste treatment operations taking place in England.

Key Issues

In 2001, The Environment Agency produced draft Technical Guidance on Composting Operations. In the decade following this draft, the use of aerobic treatment and composting to recover a range of organic wastes has significantly expanded. This is due to revised regulatory requirements and targets for diversion of biodegradable waste from landfill and increased landfill costs which have stimulated the market for the treatment of biowastes. This has resulted in the development of a range of types of aerobic biowaste treatment facilities, including in-vessel operations and the introduction of novel aerobic processing techniques, as well as the more traditional windrow composting process. There have also been significant and ongoing changes to the legislative regime under which such operations are regulated by the Environment Agency.

We view composting and aerobic treatment of organic source segregated waste as a sustainable use of resources and need to capture full use of this material by producing a stabilised compost suitable for recovery, whilst maximising resource efficiency. However, we recognise that commercial scale aerobic treatment and composting is not inherently a low risk activity. It has the potential to impact upon amenity, health, and the environment when facilities are poorly planned and operated.

Site location

Selecting an appropriate site location is fundamental for the delivery of a successful operational facility. This fact cannot be over emphasised. General concerns about odour and bio-aerosols from biological processing may require sites to be located away from sensitive receptors.

Emissions to air

The main releases from aerobic treatment operations are

- Particulates
- Bioaerosols
- Ammonia
- Volatile organic carbons (VOCs);
- Other gases e.g. Carbon Dioxide

Odour

Composting and aerobic treatment are linked to noxious and or prolonged odours. At certain times of the year and under certain local weather conditions these can intensify.

Emissions to water

It can be difficult to recycle or re-use leachate within the process where animal by-products are processed or where more novel wastes are accepted. Releases to controlled waters or sewer that does occur may be in the form of leachate or surface water discharges. All leachate or contaminated water containment must be designed to an appropriate industry standard and where necessary have secondary containment.

Significant amounts of water may be used in this sector and therefore resource efficiency needs to be considered.

Waste

The main process wastes produced in the sector are oversize material, which can be used or recovered. The other waste streams can be physical contaminants (packaging and plastic), which are land filled or sent for incineration. Some liquid waste can be produced from leachate systems or abatement systems (such as blow down valves from air scrubbing systems containing VOCs). These require assessment prior to discharge to sewer or offsite disposal and or treatment as these may be considered hazardous waste.

Vermin and Flies

Vermin and flies can be an issue for biowaste treatment sites, especially where the site receives and treats animal by-products. Measures must be taken to ensure that vermin are controlled. Birds can also be problematic and can transmit pathogens off site. These measures will be a consideration for other regulators such as the AHVLA.

Noise and vibration

Activities associated with noise and vibration pollution that could have effects beyond the installation boundary are:

- use of heavy machinery shredders, turning equipment and screening
- crushing and grinding of raw materials, solid fuels, or products;
- fans and blowers;
- material transport systems (conveyors and site vehicles).

Accident risk

The main risk of accidents that could have environmental or off-site effects are from the storage and handling of leachate, oil and fuel. Feedstock liquids and sludge’s unless adequately contained can cause offsite pollution. Combustible dry material and oversize waste material have their own potential risk of fire. On-site storage of materials such as liquid petroleum gas (LPG) and secondary liquid fuels (SLF) require construction containment built to an appropriate standard. There must be adequate provision in place on site to prevent pollution and minimise the risk of accidents. These should be clearly outlined in documented management systems.

Our Approach

Our approach to developing this guidance aims to present, a clear and accessible format describing comprehensive details concerning the types and operational principles of aerobic biowaste treatment facilities/processes. It also details all current relevant information and standards concerning the development, delivery, operation and regulation that apply to such facilities in England and Wales. As such, the guidance is considered to provide best practice principles for the development and operation of aerobic biowaste treatment facilities for source segregated wastes.

Executive summary

The Composting and Aerobic Treatment Technical Guidance is based on established practical and reliable evidence, and is intended to provide advice and guidance to a wide range of stakeholders. The principal audience are operators of existing and developers of new aerobic treatment and composting operations. The Environment Agency's regulatory staff will use this guidance as a framework for assessing new developments and current operations when assessing compliance with permitted activities. This guidance will be revised as EU Best Available Techniques (BAT) reference documents (BREF documents) are developed. It is the hoped that together with industry we can stimulate and encourage best practice across the UK.

Contents

1 Introduction

1.1 Understanding Best Available Techniques (BAT) and appropriate measures

BAT and appropriate measures requires that the techniques and measures employed provide an appropriate level of environmental protection taking into consideration the likely costs and environmental benefits of the measures and set in the context of what can be afforded in each sector. We cannot permit a composting or aerobic treatment facility where its operation would cause risk of significant pollution.

When considering what measures are appropriate for a waste operation, the same considerations apply. Practically, there is little difference between measures that are appropriate measures (environmental standards of operation) and measures that are identified as BAT. The level of environmental protection must be proportionate to the risk.

This technical guidance has been developed to provide guidance on indicative environmental standards for both installations and waste operations. It includes the technical components, process control and management of the activities. These will be applied unless departure (which may include stricter standards) can be justified for a particular activity and takes into consideration site specific risks. The document is produced by the Environment Agency England and on behalf of Natural Resources Wales.

Departures from benchmark emission levels may be justified at the site level by taking into account the technical characteristics of the process operation, its geographical location and the local environmental conditions. If any mandatory EU emission limits or conditions are applicable they must be met as a minimum.

We are required to consider the environment as a recipient of pollutants and operators are required to do all that is practicable to minimise emissions and their impact. Steps must be taken to **prevent emissions** - unless prevention is not practicable in which case they must be **minimised**. If it is economically and technically viable to reduce emissions further, or prevent them altogether, then this should be done. This approach first considers what emission prevention can reasonably be achieved and then checks to ensure that the local environmental conditions are secure.

The Regulations allow for expenditure beyond indicative BAT and appropriate measures where necessary – if for example an environmental quality standard is threatened. Ultimately, the process will only be permitted to operate if it will not cause significant pollution.

We encourage the development and introduction of innovative techniques that advance indicative environmental standards i.e. techniques which have been developed on a scale which reasonably allows implementation in the sector, which are technically and economically viable and which further reduce emissions and their impact on the environment as a whole. One of the main aims of the legislation is continuous improvement in the overall environmental performance as a part of progressive sustainable development.

Where composting and aerobic treatment is permitted as an instillation, EPR will deliver the requirements of the Integrated Pollution Prevention and Control Directive (IPPC). Under the Directive all appropriate preventative measures **must** be taken to prevent pollution, in particular best available techniques (BAT) must be used and no significant pollution must be caused.

Where they are available, the European BAT reference documents (BREFs) set out conclusions on what constitutes BAT for the sector concerned and the emission levels associated with their use. The current BREF on waste treatment does not formally apply to biological treatment. However, composting and aerobic treatment activities are still required to meet BAT. This document will be reviewed as work progresses towards a revised BREF for waste treatment, due to be published in

2016. You should ensure you are working with the most recent version of this guidance, it provides our current view on indicative BAT.

Where composting and aerobic treatment is permitted as a waste operation, appropriate measures will need to be taken to avoid the risk of harm to human health or the environment based on consideration for site-specific locations and compliance.

1.2 Composting and aerobic facilities covered by this guidance

The installation activities detailed within Annex 1 to the IED that are relevant to composting are:

Section 5.3(a)(i):	Disposal of non-hazardous waste with a capacity exceeding 50 tonnes per day involving biological treatment.
Section 5.3(b)(i):	Recovery, or a mix of recovery and disposal, of non-hazardous waste with a capacity exceeding 75 tonnes per day involving biological treatment.

IED is implemented through amendment of the existing Environmental Permitting Regulations. Defra and Welsh Government are consulting on draft amending Regulations and IED will be implemented over several years commencing from 7 January 2013. The implementation sequence is:

- 12 March 2012 launch of Defra/ Welsh Government consultation (closed 6 June 2012);
- 7 January 2013: amended Environmental Permitting Regulations enter into force;
- 7 January 2013: IED applies to all new installations from this date onwards;
- 7 January 2014: IED applies to existing IPPC installations;
- 7 July 2015: IED applies to existing installations operating newly prescribed IPPC activities (for example, specified waste recovery activities, wood preservation)

Where composting or aerobic treatment is permitted as a waste operation, appropriate measures will need to be taken to avoid the risk of harm to human health or the environment based on consideration for site-specific locations.

1.2.1 European Regulatory Context

The majority of environmental regulation in the UK is driven by the requirements of European legislation. European Directives are transposed into National legislation through Acts of Parliament and associated Statutory Instruments which are enforced accordingly. In England and Wales, the key European Directives that underpin UK legislation with respect to the regulation of the anaerobic treatment of wastes are as follows:

The Revised Waste Framework Directive (2008/98/EC): Established the waste hierarchy and set targets that prioritised recycling over recovery. This Directive and preceding waste framework directives also require a system of permitting and regulation of facilities that manage the disposal and/or recovery of wastes.

The EU Landfill Directive (1999/31EC): The landfill directive defines technical standards for the disposal of waste and sets targets for the reduction of biodegradable municipal waste disposal to land. These targets are the primary driver for initiatives on biodegradable municipal waste (BMW) as they require increasing diversion of biodegradable municipal waste from landfill when measured against a 1995 baseline at specific dates. The upper limit demands 75% diversion of biodegradable municipal waste by 2020. This Directive has been one of the key drivers for the development of alternative waste management operations to landfill, including composting and aerobic treatment.

The Industrial Emissions Directive (2010/75/EU): Combined seven existing directives (including the Integrated Pollution Prevention and Control Directive) into one Directive. Larger scale waste recovery facilities (those with a treatment capacity exceeding 75 tonnes per day) may be regulated (via their Environmental Permit) under the requirements of this Directive.

The EU Animal By-Product Regulation (EC) No. 1069/2009: The regulations include sanitary requirements for the handling and treatment in a composting facility of waste containing animal by-products. This includes food waste from commercial and household sources. The nature of the sanitary requirements can influence the suitability of feedstock or processes at facilities.

1.2.2 The Regulatory Requirements

The regulation of composting and aerobic treatment facilities, which involves waste materials is undertaken by both Local Authorities, via the planning regime and statutory nuisance, and, in England and Wales, by the Environment Agency and Natural Resources Wales through the Environmental Permitting regime (in Scotland this role is undertaken by the Scottish Environment Protection Agency, in Northern Ireland by the Northern Ireland Environment Agency).

Further regulatory controls can be applied by Animal Health (should the process involve any wastes covered by The Animal By-Products (Enforcement) (England) Regulations 2011) or, in Wales, The Animal By-Products (Enforcement) (Wales) Regulations 2011) and the Health and Safety Executive.

The main purpose of this section of the document is to provide guidance on our current regulatory requirements in England and Wales, however information is also provided concerning the requirements of other regulatory bodies where there is an overlap or they integrate with our regulatory requirements.

This section of the guidance primarily applies to the composting and aerobic treatment of materials consisting of or including wastes. The Government has provided guidance on the meaning of waste in the Waste Framework Directive in its Environmental Permitting Guidance "The Waste Framework Directive", Chapter 3 (see links in Appendix 12.4)

Whilst all the regulatory information within this document is correct at the time of publication, it is recommended that anyone wishing to develop and operate a composting or aerobic treatment facility should check whether there have been any applicable new regulatory requirements applied since publication.

1.2.3 Environmental Permitting for Composting and Aerobic Treatment Facilities in England and Wales

The following section provides an overview of Environmental Permitting in England and Wales and how it applies to composting facilities. Additional information can be found in the Environmental Permitting section of our website (see links in Appendix 12.4). In England and Wales, the permitting requirements and standards of the Waste Framework Directive (WFD) and the Industrial Emissions Directive (IED) are applied by the Environmental Permitting (England and Wales) Regulations 2010 (the EPR) and their associated amendments (The Environmental Permitting (England and Wales) (Amendment) Regulations 2011 and The Environmental Permitting (England and Wales) (Amendment) Regulations 2012). Further amendments to the EPR The Environmental Permitting (England and Wales) (Amendment) Regulations 2013, came into force in January 2013.

The National Indicator handbook defines composting as; ‘the controlled biological decomposition and stabilisation of organic substrates, under conditions that are **permanently** aerobic. We have taken a more pragmatic approach and define of composting as “autothermic and thermophilic biological decomposition and stabilisation of biodegradable waste under controlled conditions that are **predominantly** aerobic” results in stable sanitised material that can be applied to land for the benefit of agriculture or to improve the soil structure or nutrients in land.”

Composting and aerobic treatment facilities in England and Wales that process waste materials above the specified threshold will require an Environmental Permit issued under the Environmental Permitting (England and Wales) Regulations 2010 (as amended). These permits are issued and regulated by the Environment Agency (EA) or Natural Resources Wales (NRW). It is necessary to apply for and obtain an Environmental Permit from us before operations commence.

From 7th January 2013, composting facilities with a treatment capacity of up to 75 tonnes per day or less will require an Environmental Permit as a waste operation. Operations with a treatment capacity of greater than 75 tonnes per day will require an Environmental Permit as a composting facility (under Section 5.3(b)(i) to Annex 1 of the Industrial Emissions Directive). Other authorisations i.e. planning permission must be in place before an Environmental Permit can be issued.

In order for an Environmental Permit to be granted, we must be satisfied that the activity will be operated in a manner that prevents pollution of the environment and harm to human health. The permit conditions indicate what needs to be done to prevent different types of pollution, e.g. odour pollution will be assessed differently from groundwater pollution. Our guidance document “How to Comply with your Environmental Permit” provides more information; this is available from the Environmental Permitting section of our website (see links in 12.4 Appendix 4).

For waste operations permitted under the WFD, operators are required to demonstrate that they will take all appropriate measures to minimise and prevent unacceptable pollution of the environment and harm to human health. This includes offence to senses and loss of amenity.

For waste composting facilities permitted under the IED, operators must demonstrate that their activities satisfy the criteria of Best Available Techniques (BAT), providing an assessment and justification of their proposals against relevant Sector Guidance Notes (SGN) and BAT Reference Standards (BREF).

For further information and guidance on what type of permit a proposed facility may require can be found at the Environmental Permitting section of our website (see links in Appendix 12.4). This provides details of all current exemptions and standard rules permits, plus guidance on how to make an application for an Environmental Permit. We have produced a number of horizontal guidance documents, the purpose of which is to provide information relevant to all sectors regulated under the Environmental Permitting Regulations (EPR), for example, noise, odour, energy efficiency and protection of land (see links in 12.4 Appendix 4).

1.2.4 Exemptions from Requiring an Environmental Permit

Exemptions have a simple registration process do not attract a fixed fee. Operations are required to reregister every three years. Certain criteria must be satisfied in order for an activity to be able to operate under an exemption, including restrictions on location, waste types and quantities. Any composting facility that registers for an exemption must meet all the requirements in full, otherwise a permit is required.

Operators should be aware that the types of exemptions and the criteria that apply to exemptions, can be changed or new ones added. To check on the current position with regard to available exemptions for composting facilities and to find guidance on how to register an exemption please go to the waste exemptions page of our website (see link in Appendix 12.4).

1.2.5 Standard Rules Permits

Standard Rules Environmental Permits (SRP) are available where the size/scale, location and types of operation are such that the level of environmental risk from the operation is suitable for control by such permit. They have a simpler application process than bespoke permit applications and also attract a lower fixed application fee and subsistence charges.

Certain criteria that must be continually satisfied (including adoption of measures set out in the generic risk assessments) in order for an activity to be able to operate under a SRP, including restrictions that are associated with the location waste types and quantities. If all the standard rules cannot be met then a bespoke permit is required.

Operators should be aware that the criteria for permits can be changed or new ones added. To check on the current position with regard to available SRPs for composting facilities, please go to the standard permits page of our website (see links in Appendix 12.4).

Guidance on applying for a SRP can be found in the Environmental Permitting section of our website (see links in Appendix 12.4).

1.2.6 Bespoke Permits

Where a composting or aerobic treatment operation does not meet the criteria for an exemption or a SRP, then a bespoke permit (also known as a Tier 3 permit) will be required. Applications for bespoke permits require a significant amount of additional and supporting information to be provided in comparison to SRP and specialist assistance may be required to produce some of the required information. Guidance on applying for a bespoke permit can be found in the Environmental Permitting section of our website (see links in Appendix 12.4).

An understanding of regulatory requirements is strongly recommended prior to proceeding with initial site design as it may inform the design process.

One of the key elements of a bespoke application is the requirement to undertake and submit environmental risk assessments to support the application. Risk assessments should be undertaken in accordance with the H1guidance. Information on the requirements for a bespoke Environmental Permit application can be found on our website (see links in Appendix 12.4).

1.2.7 Animal By-Product (ABP) compliance

If there is a requirement for a site to comply with ABPR legislation, the on-site supervisor must keep records of any animal by-product or food waste that is delivered to site. This must include the following information:

- The date of delivery;
- The quantity and description of material;
- The name of the haulier; and
- For food waste only, details of how meat was kept separate at the source.

The supervisor should keep records of the dates of treatment, quantity treated, a description of the material treated. Details of the movement of material off-site must also be recorded and retained for a period of at least two years.

Further information regarding the ABPR approval process can be found on the animal health website (see links in Appendix 12.4).

1.2.8 Planning

We are statutory consultees to the planning process. Our response to the planning process is based on the information placed before us by the planning authority. Where there is a lack of information on protection measures or the facility is located in a particularly sensitive area – e.g. a Ground Water Protection Zone 1, we may object. Some more contentious or difficult sites may twin track planning and permitting applications. We also consult planning authorities when a bespoke application is received.

1.2.9 Applying for an Environmental Permit

It is strongly recommended that operators contact us to undertake a pre-application discussion with the Area Environment Management Team prior to submission of an application. They will be able to provide advice on the type of permit that should be applied for, the application process and any relevant local environmental issues that may affect the application. Advice can also be sought from our National Permitting Service (NPS). It should be noted that there is a maximum 15 hour limit for free advice for bespoke permits and two hours for standard rules permits, following which, charges may apply. Although operators are not obliged to undertake pre-application meetings, it may reduce delays to the permitting process or even the chance of a refusal where all the considerations of the proposed site and activity have not been taken into account.

1.2.10 Permit review periods

Permits are likely to be reviewed as follows:

- for individual activities not previously subject to regulation under EPR or Waste Management Licensing, a review should be carried out within four years of the issue of the EPR Permit
- for individual activities previously subject to regulation under EPR or Waste Management Licensing, a review should be carried out within six years of the issue of the EPR Permit

However, where discharges of Groundwater List I or List II substances have been permitted, or where there is disposal of any matter that might lead to an indirect discharge of any Groundwater List I or II substance, a review must be carried out within four years as a requirement of the Groundwater Regulations.

These periods will be kept under review and, if any of the above factors change significantly, they may be shortened or extended.

1.2.11 Timescales for upgrading existing facilities

Unless subject to specific conditions elsewhere in the permit, upgrading timescales will be set in the Improvement Programme (IP) of the permit, having regard to the criteria for improvements in the following two categories:

- Standard "good-practice" requirements, such as, management systems, waste, water and energy audits, bunding, measures to prevent fugitive or accidental emissions, good waste handling facilities and adequate monitoring equipment. Many of these require relatively modest capital expenditure and so, with studies aimed at improving environmental performance, they should be implemented as soon as possible and generally well within 3 years of issue of the permit.

- Larger, more capital-intensive improvements, such as major changes to treatment systems or abatement equipment. Ideally these improvements should also be completed within 3 years of permit issue, particularly where there is considerable divergence from relevant indicative BAT standards, but where justified in objective terms, longer time-scales may be allowed by the Regulator.

Local environmental impacts may require action to be taken more quickly than the indicative timescales above and requirements still outstanding from any upgrading programme in a previous permit should be completed to the original time-scale or sooner. Where an activity already operates to a standard that is close to an indicative BAT requirement a more extended time-scale may be acceptable.

Unless there are statutory deadlines for compliance with national or international requirements, the requirement by the Regulator for capital expenditure on improvements and the rate at which those improvements have to be made, should be proportionate to the divergence of the facility from indicative BAT standards and to the environmental benefits.

1.3 Key issues

Biodegradation of wastes

Consistency of waste feedstock and seasonal variability, sampling and monitoring during the treatment process, residence time in treatment and controls of parameters, including windrow height, temperature, moisture and C:N ratio, for adequate aerobic treatment; maximising treatment and producing a fully stabilised compost.

Poor design, the introduction of waste types without proper evaluation and poor process control can severely reduce the efficiency of the process and quality of end material.

1.3.1 **Odour**

The handling and processing of waste or any substance that is or may contain a volatile organic compounds or other odorous substances will potentially lead to odour noticeable beyond the site boundary, even at concentrations that may be well below benchmark emission limit values.

Odours may arise from the waste reception and handling area, from open reception areas and from storage of the material. Failure to adequately understand ‘inventory’ of odorous compounds, inspect and maintain plant and equipment is a contributory cause to fugitive emissions.

Composting on aerobic treatment sites may produce odours as a result of normal operations and odours can become significant if there are local sensitive receptors. Recognising where the potential release of odorous compounds may arise is paramount in order to design out potential releases or manage and minimise odours from the site.

An odour management plan (OMP) should be developed in accordance with Horizontal Guidance H4. For a bespoke permit, the OMP will be submitted for approval on application.

An odour management plan should detail the type of material the site will be treating, the type of odours that are likely to arise from various parts of the process and the mitigations that have been put in place to reduce or prevent these odours from impacting on local sensitive receptors.

1.3.2 **Loss of containment**

Loss of containment can give rise to release of emissions, contamination of groundwater, water bodies as well as give rise to odour. Losses can arise from poor handling of material, overfilling or over stocking feedstocks and failure of equipment. All foreseeable events should be planned for and contingency is usually required to prevent pollution.

1.3.3 **Releases to Air**

Fugitive releases include odorous compounds, bio-aerosol and dust. Operational management and abatement technologies or characteristics should ensure that the impact is prevented or minimised. Some releases may have permit requirements which will need to be complied with.

1.3.4 **Systems and procedures**

We strongly support the operation of a dynamic environmental management system. Operators who employ such a system will find it easier to meet good management of the treatment process and meet many of the technical/regulatory requirements presented in this guidance. A management system needs consider the location, waste types treated, size of your site, and complexity of your process.

2 Design and Construction

2.1 Introduction

Aspects of site design should be well thought-out when planning/designing any composting or aerobic treatment facility. Table *1* summarises the stages and activities that should be considered in the design development.

Design Stage	Types of Activity to Consider	Aspects to Consider
Preliminary Design	• Site selection • Identify site specific receptors and environmental issues • Determine waste types to be treated • Identify site design constraints • Open discussions with regulators • Pre-application discussion with relevant authorities/regulators • Prepare outline design and preliminary risk assessments (including health and safety) • Undertake outline modelling assessments of impacts • Develop business case for facility • Develop stakeholder engagement plan or community engagement plan • Contingency planning/business risk	• Planning • Location to sensitive receptors • EIA - is it needed? • Site Drainage • Site Suitability • Applicable regulations • Type of environmental permit • Capacity • End use • Vehicle Access • Utilities
Detailed Design	• Establish infrastructure design requirements, including quality of materials, insulation, particularly with enclosed systems (compost condensates are very corrosive). • Feedstock's to be managed • Consideration of the site management system • Develop construction Quality Assurance Requirements for facility • Assess workforce requirements • Develop contract specification for equipment supply and construction (HAZOP) • Contingency arrangements for dealing with contaminated feedstock to be included in contracts • Abatement technology design (HAZOP) • Emergency planning • Assessment contingency arrangements for facility in the event of failure • Undertake background environmental monitoring and continue dialogue with Regulators. • Commissioning phase	• Planning • Stakeholder engagement • Feedstock Unloading area • Active Composting Area • Compost Maturation • Screening and Refining • Packing and Storing • Proposed end use market • Fire • Flooding and extreme weather • Size and configuration of abatement

Table 1: Design stages and activities to be considered

Operators are advised to have pre-application discussions with the Environment Agency and other regulatory bodies. Where sites are liable to be contentious or attract high public interest it is advised that planning and permitting should be applied for simultaneously to allow constructive discussion with regulators. In this case an Environmental Impact Assessment (EIA) may be necessary. Waste operations permits cannot be issued without the appropriate planning permission being in place. The planning must reflect entirely the intended operations as this will be checked during the permit determination. Restrictions within the planning permission granted may be reflected within the permit.

2.2 Site Suitability

Selecting an appropriate site location is critical to delivery of a successful operating composting facility. Appropriate location can be the most effective way to deal with potential impacts on the local environment. Operator/ developers should take account of:

- Proximity to sensitive receptors and pathways
- Topography;
- Prevailing weather conditions;
- Ground conditions;
- Access to vehicles and their impact in respect to traffic movements.

2.2.1 **Proximity to sensitive receptors**

The Environment Agency's "Composting and potential health effects from bioaerosols: guidance for permit applicants" (included here at Appendix 12) refers to the need for open processing sites within 250m of a sensitive receptor to submit a site specific bioaerosol risk assessment (detailing suitable mitigation measures where appropriate) with their permit application. There may be cases where a permit will not be supported or considered if the applicant cannot demonstrate that suitable mitigation measures will be in place.

Proximity to residential, commercial and other industrial premises will determine the amount and type of environmental controls that will be needed. Early local engagement can develop better relationships with local communities.

Site selection and thorough identification of sensitive receptors can avoid conflict at the application stage. Failure to identify and address all the issues may result in additional expense later on or even permit refusal. Consultation with Natural England, English Heritage or Natural Resources Wales (NRW) may also be needed at an early stage in these circumstances.

2.2.2 **Topography**

Topographical surveys and emission modelling can help inform design. Topography and prevailing weather may affect dispersal of airborne emissions. Modelling should be viewed with care as it is only one part of the overall risk assessment. For example a lower level of odours can give rise to complaints that would not have been predicted by modelling. Specific issues such as location in deep valleys or on hillsides must be carefully assessed.

2.2.3 **Prevailing weather conditions**

Weather conditions must be taken into consideration when planning a composting facility. For example an exposed position with windy conditions may be unsuitable for an open windrow site where on and offsite dust and emissions could be exacerbated during feedstock preparation and turning operations.

2.2.4 **Ground conditions**

Guidance advises the identification of groundwater protection zones in relation to a potential site, (The Composting Association, 2005) as the presence of a protection zone may affect the ability of a site to secure an Environmental Permit. For further details please refer to The Organics Recycling Group (REA)'s (formally AfOR) document titled *The Composting Industry Code of Practice* (2005) and horizontal guidance document H1 (see links in Appendix 12.4).

2.2.5 **Transport**

Transport links and other site specific factors, such as proximity to residential development or other sensitive receptors or flood risk etc may result in planning restrictions. These could impact on the feasibility of the site.There should also be consideration at the design stage of ensuring adequate vehicular access.

2.2.6 **Emergency and accidents**

Consideration should be given emergency situation sin site design. For example, services and utilities e.g. availability to foul sewer for handling water containment in the event of fires or sprinkler systems, or extreme weather events.

2.3 Site Layout

A composting process can result in repeated handling of material. Good site design can minimize handling of material and so prevent cross contamination. This could include only allowing the composting material to move in one direction through the system, avoiding the crossing over of vehicles and defining locations for processed material and feedstock's. Site layout becomes more critical in compliance with ABP Regulation.

The layout should separate pedestrian areas from the vehicular operational areas. Public access to the site should be limited and should be a safe distance from the operational areas. The unloading areas should also be kept separate from the main routes used for traffic flow on site.

Unloading and preparation areas should be located in close proximity and may need to take account of spacing to enable the location of preparation equipment (e.g. conveyor belts, grinders, shredders, front end loaders, and storage for bulking agents (such as clean woodchip etc). Processes such as screening will also need to be factored into site layout configuration ensuring that sanitised stabilised material is not cross contaminated.

If the site is aims for compliance with BSI:PAS 100 and the Compost Quality Protocol (CQP) then attention to these requirement will be critical and should factored at the design stage If the feedstock does contain animal by-products then the unloading and preparation areas must be fully enclosed. For further requirements and details please refer to the ABPR Regulations guidance which can be downloaded from the AHVLA/Defra website (see links in Appendix 12.4). If applicable, to obtain ABPR approval an operator will be required to develop a HACCP plan that identifies, evaluates and controls hazards which are significant.

The HACCP approach is as follows:

- Conduct a hazard analysis
- Determine the Critical Control Points (CCPs)
- Establish critical limits
- Establish a system to monitor control of each CCP
- Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control

2.4 Design capacity and throughput of composting facilities

The potential capacity of a facility is ultimately constrained by the size of land holding available. This is a factor that needs consideration when selecting the site so that overcrowding or rapid throughput does not become an issue on site.

Operators should refrain from attempting to increase throughput at the detriment of good site design and operation. The facility design must ensure that there is sufficient space for feedstock unloading, feedstock preparation (e.g. shredding and contaminant removal), active composting, maturation, screening, refining, storing and packaging. Operators also need to prepare for the seasonality of green waste as well as the quantity of this waste stream is higher during the spring and summer period the waste and also tends to be significantly higher in nitrogen. Operators may therefore, depending on the feedstocks being treated, need areas on site to store woody or other high carbon material to rebalance the compost carbon to nitrogen ratio to optimal conditions.

Failure to take account of these issues is recognised to lead to operational issues once facilities are expanded or developed. Issues may include the requirement for additional handling of the material, incomplete stabilisation or maturation of the compost, and cross contamination of feedstocks and finished material. As well as creating nuisance (e.g. odour) these issues may affect the market value of the finished product if it fails to meet agreed specifications within supply agreements and may ultimately affect the continuation of the composting operation.

There are many examples of typical footprints that are required for different configurations and throughputs. However, composting sites become overloaded due to the slim economics and reliance on the gate fee to remain viable. These sites often suffer from poor process control and are difficult to manage resulting in pollution and nuisance.

In determining realistic site capacity developers should take into consideration:

- existing facility capacities that have been commercially delivered so as to gain an understanding of what can be feasibly delivered on the site and issues which have been encountered at these operational sites.
- the Environment Agency Bioaerosol Position Statement (EA 2010/11) which provides information in terms of site handling capacity and the implications in terms of whether a standard or bespoke permit will be required and in the case of the latter, also a SSBRA.

Developers should note that the tonnage limits within a standard rules permit may be larger than the facility is able to handle; standard rules permit SR2008No16 has an annual throughput limit of 75,000 tonnes but a facility may be only big enough to handle only 10,000 tpa. If the operator were to attempt to put 75,000 tonnes per annum through that facility it is likely to result in incomplete stabilisation or maturation with the potential to cause pollution and breach other elements of the permit.

Therefore the onus is on operators to determine the appropriate throughput for their site based on the constraints imposed by the available space, proposed process and economics of the facility.

The outcome of this determination should be detailed in the environmental management system for the site that is required by the standard rules permit.

2.5 Operational areas

Composting sites can be generally sub-divided into the following functional areas:

- feedstock unloading and preparation,
- active composting,
- maturation and
- finishing/storage.

Each of these functional areas has different technical and organisation requirements and each is discussed in further detail in the sections below.

2.5.1 **Feedstock unloading and preparation area**

For permitting purposes, the operating areas of composting facilities for unloading, preparing and processing feedstock should be an impermeable paved surface (i.e. to prevent the transmission of liquids beyond the pavement surface) designed to the relevant Eurocode or British standard. Operators shall demonstrate that the surface design is suitable to accommodate all of the static and dynamic loads imposed by the vehicles, stored materials, machinery and process plant within the proposed facility.

The pavement design, construction and maintenance should take into account the movements, reversing and tipping of vehicles, the use of unloading areas for storage of waste, the use of mechanical shovels on the floor to move waste, water containing contaminants dripping from vehicles and the washing down of the floor for cleaning purposes. Feedstock unloading and preparation areas should be finished with a proprietary finish to provide sufficient resistance to chemicals and abrasion for the stated design life. The surface should have appropriate skid resistance and be suitable for pressure jet washing. Permits issued under SRP state that surfaces should be impermeable; any deviation presumes a bespoke permit will be needed with a justified risk assessment.

2.5.2 Active composting area

As a typical value, an area of 0.8 square metres per cubic metre of feedstock material will be required for a windrow operation. The area required will depend on the type of feedstock and the process. The layout must avoid of cross contamination of new and processed sanitised material.

An example comparison of the volumetric footprint for two standard types of windrow system for aerated static pile and turned windrow are presented in Table *2*.

Windrow System	Aerated Static Pile	Turned Windrow
Length of pile (m)	20 – 30	46
Height of pile (m)	1.5 – 2.5	1.5 – 3
Width of pile (m)	3 – 6	2.4 – 2.7
Overall Volume (m^3)	**75 – 375**	**131 – 221**

Table 2: Active composting area in linear distances (m) and volumes (m^3)

In addition to the volumetric amounts identified in the table 2 above, operators must also take into consideration the gaps between windrows, these gaps should be sufficient to provide separation between batches to allow adequate process control (passive aeration for open facilties), and allow machinery to operate without traversing the edge of piles. This is specific to open windrow processing.

The dimensions for an aerated static pile need to take into account the ability of the air pipe system to deliver adequate air circulation to the composting pile. In the case of the turned windrow system, the width and height reported relate to mechanical turning and are limited by the dimensions of the turning equipment. The length of a turned windrow can theoretically be as long as required. Practically, the length of the windrow is likely to be constrained by the space available at the selected site under impermeable surfacing and the method of turning adopted (see section 5).

A deep clamp or stack composting is usually modular and more than one clamp can be established at a single site. This method can result in material becoming anaerobic as it is difficult to monitor and react to conditions within a large block or clamp.

By comparison, in-vessel composting areas are affected by the type of technology under consideration and in particular the spatial arrangement of the In-vessel reactor and the retention time for feedstock materials.

Actively aerated in-vessel systems can be divided into two main types (1) vertical and (2) horizontal.

Horizontal systems are similar to windrow systems, the feedstock is placed in a pile in enclosed conditions. The volume of horizontal systems can be much larger than vertical. A tunnel system 4-5m wide, 3-4m high and up to 30m long, has an indicative active volume of 450m^3. These systems can be modular, for example 30 tunnels with a capacity of around 2,880m^3 at any one time.

The above data is a guide only. It is important that developers engage in early dialogue with technology suppliers to ensure that the chosen technology system can be accommodated on the proposed site and that material can be processed in a manner that is compliant with permit conditions.

2.6 Compost maturation and curing

A key consideration is the requirement for a separate curing or maturation area following the active phase of composting.

Maturation areas can be open or under cover, however they must be designed to allow for leachate, bioaerosols and odour management requirements to be met.

Site design and operational practices must ensure that contamination of maturing finished material is avoided. Cross contamination between sanitised and finished material product is a critical control point or risk which needs management and process control. This is required by the ABPR and recommended for green waste.

Separate handling equipment or provision of steam cleaning facilities for equipment should be considered, especially if the site is process Animal By Products.

2.7 Screening and Refining

Compost is screened in order to achieve one or more size grades of compost for different end markets. Screening is also performed to remove large physical contaminants including glass, metal, plastics and stones. Oversize woody material may be blended back into the process as a bulking agent.

Screened compost must be managed appropriately both in terms of ensuring adequate areas to effectively screen and separate contaminants to ensure that contaminants are screened out post process and the finished compost is not allowed to come into contact with new feedstock materials. Cross contamination may result in a sanitised batch being contaminated with unsanitised biodegradable wastes, and requiring the material to re undergo sanitisation prior to release to markets/ disposal points for the operator. Clear segregation is a requirement of ABPR regulation and should be considered best practise at all site, incorporated into site design and risk control systems.

Screening presents an increased risk of release of odour, dust and bioaerosols. Permit conditions may require these operations to be carried out in enclosed buildings to manage risk and control point source emissions. Operators should consider the requirements of permit conditions and the health and safety of operators when designing site infrastructure.

2.8 Fire

Fire outbreaks are more common in feedstock piles and separated physical contaminant piles or oversize, but can occur in active composting piles.

The most common causes of fires are;

- self combustion (due to excess heat and chemical and biological reactions)
- storage of incompatible materials
- ignition of flammable vapours
- incidents related to welding and cutting
- electrical faults/heating faults/plant and equipment failures
- naked flames/smoking
- neighbouring site activities and
- dusty material in confined spaces self igniting/explosion.

The Environment Agency has published a set of Pollution and Prevention Guidance Notes to help deal with accidents and emergencies on site. In addition the Environment Agency is currently preparing guidance on the safe storage of combustible materials to prevent and control fires, specifically focussing on large fires at waste recycling facilities.

The operator must also be aware of the risk of fire when stockpiling material which is perhaps not fully matured and is still at risk of producing heat as part of the stabilisation phase. Operators should take appropriate measures to guard against this, such as reducing the size of the pile and monitoring the temperature and moisture content of the material and taking corrective actions as necessary

Any site design must take risk of fire into account and install appropriate fire detection, management plan and fire fighting equipment. Sprinkling systems should be considered in buildings. In addition, the layout and site design should allow the visual inspection and monitoring of the waste. ‘Contrary waste’ storage should be minimised and be removed as a soon as is practicable or in any event no longer than five working days. Please refer to the Environment Agency website for further information about fire prevention.

The potential fire risk in a well run aerobic composting facility should be low, provided the system is adequately managed, not allowed to get too hot, dry out or become anaerobic or allow unstable physicochemical conditions to develop. Measures should be put in place to prevent or in such an emergency limit the size, duration and impact of any fire should one break out.

To ensure that site design has considered the requirement to deal with fires adequately developers need to understand:

- Where are fires likely to start on site?

- How are they likely to be generated?
- How the fire will burn and the risk of fire spread
- When are they most likely?
- How can they be prevented?

With the above risks identified the developer must consider how site design allows for fires to be managed on site, for example:

- Fire suppression systems, e.g. sprinklers, water spray (deluge systems) water curtains and fixed monitors;
- Fighting strategies e.g. equipment/water supplies/fire ponds/controlled burn;
- Means of applying water to all areas site including within stacks where fire is likely; and
- Equipment /Areas to allow burning materials to be separated from the fire so that it can be quenched with hoses or in pools tanks of water.
- Contained and sealed drainage to allow containment of fire fighting water i.e. means of blocking drains, storage lagoons, tanks and the testing and removal of fire fighting water from site.
- Contingency for fire water disposal.

Developers should refer to The Regulatory Reform Fire (Fire Safety) order 2005, the Pollution and Prevention Guidance Note PPG 18 – Managing Firewater and Major Spillages, PPG 21 – Incident Response Planning and Getting your Site Right pack which recommends the development of a pollution incident response plan to prevent harm to human health and minimise damage to the environment caused by accidents, fires or spillages. Advice should also be sought from the local Fire and Rescue Service (FRS) and it is recommended that the information in the site plan is also included in the FRS own operational incidents plans for the site often referred to as 7(2)(d) or 9(2)(d) plans, reference 16.

2.9 Packing and Storing

Site design should take account of the requirement to store finished product ahead of delivery to markets. The product area should be protected to maximise quality and minimise emissions such as runoff, odour, dust and bioaerosol emissions. Under cover storage is advised where sites are located within 250m of a sensitive receptor. The area required will depend on the throughput of the plant and the frequency of removal of the product to market. Operators need to ensure that the storage area is used under appropriate permission. This applies to compost certified under the quality protocol scheme. Reprocessing material to further improve or change grading size should be carried out with the permitted area.

2.10 Site Drainage

“Controlled waters” include all watercourses, lakes, lochs, canals, coastal waters and water contained in underground strata (or “groundwater”), and it is an offence to pollute such waters - deliberately or accidentally. New sites should be designed and constructed to separate clean surface water and dirty water/leachate. Surface water drains (including land drains and road drains) should carry only uncontaminated rainwater, as they will be likely to be discharged to a local river, stream or soak away, unless these are identified as combined surface sewer systems Surface water should be harvested on site and stored for use in the process. Foul water drains are designed to carry contaminated waste water safely to a storage lagoon, treatment system or sewage works for treatment. Trade effluent discharge consent will be required from the local sewerage undertaker. Simple site design or improvements can minimise foul water discharged from a composting facility. This saves cost of disposal in the longer term.

Where significant work is being undertaken on an existing site or a new development, the Environment Agency encourage the consideration of an alternative approach for clean surface drainage, which uses a combination of techniques known collectively as Sustainable Drainage Systems (SuDS). This approach has significant environmental benefits and may also have lower installation costs. Information on SuDS is provided by the construction industry research and information association (CIRIA) (see links in Appendix 12.4)

In addition The Flood Estimation Handbook (Centre for Ecology and Hydrology, 2009) provides information and methodologies on how to estimate rainfall intensity, storm and flood events and how to calculate the rainfall runoff, specific to a location in the UK. This information can then be used with SuDS best practice to design attenuation and storage features such as lagoons etc.

Developers should also refer to Section H of the Building Regulations 2000 that can be downloaded for free from the planning portal (see links in Appendix 12.4) and outlines the design requirements for drainage and waste disposal, including the drainage of paved areas.

Regardless of the method chosen to deal with site drainage requirements, operators are responsible for complying with environmental regulations and for preventing pollution of air, land and water. Any discharges to controlled waters, unless it is a discharge of clean, uncontaminated rain water from roofs and parts of the site not used for any waste treatment or storage, must be assessed in accordance with EA Horizontal Guidance H1 Annex D and the assessment included within the bespoke environmental permit application for the site (no such emissions are allowed by standard rules permits). Once issued, the permit will contain conditions and emissions limits relating to any such discharge.

The Environment Agency has produced a series of Pollution Prevention Guidance (PPG) which provide practical advice that will help operators to avoid causing pollution, minimise waste and comply with the requirements of the law. These are readily available on the Environment Agency website (see links in Appendix 12.4)

In addition the Environment Agency has a pack of information which is designed to help industrial and commercial sites put effective pollution prevention measures into practice. The pack is called “Pollution Prevention Pays” and includes a booklet, posters and video. There is also a checklist “Is Your Site Right” which can be used to help quickly check whether your site is operating correctly. The “Is Your Site Right” checklist is available on the Environment Agency website (see links in Appendix 12.4).

The pack states that effective measures can be put in place once an environmental review, in the form of a site audit is carried out; this covers legal requirements, areas of risk, resource management and waste minimisation and community relations. An environmental review is the first step towards developing an Environmental Management System (EMS), which provides the framework for a company to deal with the immediate and long-term environmental impact of its products, services and processes. The Environment Agency and other independent organisations can help and early dialogue is recommended. Many of the measures and ideas for improvement can be implemented at little or no cost.

In addition the Environment Agency has also published a guide called “How to Comply with you Environmental Permit” which is relevant to waste operations and contains guidance on site drainage.

2.10.1 Permitting requirements for site drainage

Standard rules permits define various features, such as distance to water courses and sensitive receptors. With regard to drainage the permits state that the activities shall not be within:

- 10 metres of any watercourse;
- 50 metres from any spring or well, or from any borehole not used to supply water for domestic or food production purposes; and
- 250 metres from any well, spring or borehole used to supply water for domestic or food production purposes.

These standard rules do not allow any point source emission into surface waters or groundwater. However, under the emissions of substances not controlled by emission limits rule:

- Liquids may be discharged into a foul sewer subject to a consent issued by the local utility company.
- Liquids may be taken off-site in a tanker for disposal or recovery.
- Clean surface water from roofs or from areas of the site that are not being used in connection with storing and treating waste, may be discharged directly to surface waters, or to groundwater by seepage through the soil via a soakaway subject to permission.

In addition, the introductory note on the Standard Rules Permit for composting biodegradable waste also states that, the storage, physical treatment, composting and maturation of wastes shall take place on an impermeable surface with sealed drainage. The note also defines an impermeable as; 'a surface or pavement constructed and maintained to a standard sufficient to prevent the transmission of liquids beyond the pavement surface. 'Standard rules permits define sealed drainage system in relation to an impermeable surface, and means a drainage system with impermeable components which does not leak and which will ensure that:

(a) no liquid will run off the surface otherwise than via the system;

(b) except where they may lawfully be discharged to foul sewer, all liquids entering the system are collected in a sealed sump.

Information on appropriate concrete specification is provided by the construction industry research and information association (CIRIA) (see links in Appendix 12.4).

Developers should carefully consider the above definitions as a minimum early in the development process and engage with the Environment Agency at site selection and design stages to ensure that the permit conditions can be met.

If an operator cannot comply with the suggested standards, or meet any of the specific criteria, then they must apply for a bespoke permit. The application must include additional information about the how risks are identified and managed.

The Environment Agency has published guidance to help operators complete an application and comply with the conditions of their environmental permit (see links in Appendix 12.4).

2.11 Transport networks

A proposed development should be considered in relation to transport networks. This will influence the ability to receive feedstock and delivery of outputs to market. This may include an assessment of the types and size of vehicle that may arrive on site. Operators should also be aware of potential planning restrictions that may result in a facility being required to accept lower tonnages than expected. This may be as a result of restrictions on the number of vehicle movements per day, or on the operational hours of the facility.

A one way system for traffic will provide greater safety, particularly where third parties (sub-contractors, public) may be visiting the facility.

2.12 Utilities

The design of a site should include access to all necessary utilities. This typically includes water, electricity and sewerage as required. Proximity to foul water and surface water should be assessed as this will affect the suitability for development if located remote from the site. Sites will need to have appropriate facilities for the storage of leachate from the composting process areas.

3 Overview of the Composting Process

3.1 General Principles and Definitions

Haug, 1993 defines composting as “the biological decomposition and stabilisation of organic substrates, under controlled aerobic conditions that allow development of thermophilic temperatures as a result of biologically produced heat, to produce a final product that is stable, has a reduced pathogen load and plant seeds, and can be beneficially applied to land.”

Composting is a natural process in which micro-organisms break down biodegradable matter in the presence of air to form a humus-like product. Good quality compost is a proven organic supplement that can improve yields from poor quality soils through the provision of nutrients and humus. Humus is a complex, stable, non-cellular, long lasting naturally occurring organic material that is found within soils. It is beneficial in soil due to its moisture and nutrient retention properties. Composted material will contain nutrients and will continue to break down, with the end point of the process being humus, this is a process that will take several years to complete.

The composting process relies on aerobic micro-organisms, which require oxygen and produce carbon dioxide and water. During the process a large amount of energy is released in the form of heat; this leads to elevated temperatures within the composting material. The microbiological composting activity occurs in the moisture film around the particle, therefore for the composting bacteria to make use of any feedstock or nutrients it is necessary that moisture content is optimised.

Feedstocks for composting have traditionally included manures, garden waste and parks waste, consisting of tree trimmings and grass cuttings. More recently, following the introduction of targets to divert Biodegradable Municipal Waste (BMW) from landfill, the technique has been extensively applied to the treatment of household food wastes. The Government Review of Waste Policy in England (Defra, 2011) has also identified Commercial and Industrial wastes (C&I) for improved recycling (including composting). This includes organic material that may contain meat products.

The composting process has also been applied to sewage sludge, industrial sludges and by-products from industrial food preparation.

3.2 Description of Key Stages

The composting process uses micro-organisms to degrade organic material. The range of micro-organisms is vast and populations are sensitive to temperature changes. The phases of composting result in a range of temperatures which gives rise to a succession of microbial populations. Heat is released by the micro-organisms as they degrade the waste. Due to the compost mass being an effective insulator, much of the heat is retained within the system. The combination of this self-generated heat release and retention results in a temperature increase. An increase in temperature changes the populations of mesophilic and thermophilic organisms. Microbes of importance to the composting process include bacteria and fungi.

The composting process can be broadly split into phases that are typically represented by the temperature profile of the material, namely:

- Mesophilic heating
- Thermophilic heating

- Thermophilic steady state
- Reduction in activity and cooling

Most commercial composting systems will experience both thermophilic and mesophilic phases. These phases describe the temperatures experienced; during the initial increase of mesophilic activity to a thermophilic phase where temperatures between 45°C- >70°C can be experienced. This is usually followed by a mesophilic phase with temperatures of typically 20°C-45°C. If these temperature profiles are not managed vigorously oxygen becomes depleted and the process can quickly become odorous. Substances such as ammonia and hydrogen sulphide can be produced together with odorous intermediate breakdown products.

The temperature of the pile is an indicator of the generation and loss of heat by the composting system, with heat being generated by the micro-organisms as they degrade the waste. Due to the compost mass being an effective insulator much of the heat is often retained within the waste or system. The combination of this heat generation and retention results in a temperature increase. An example of temperature profiles is shown in Figure 1 below.

Figure 1 is a laboratory scale example, under controlled conditions and is only provided as a representation of the relationships that exist between the microbial population and temperature, showing heat outputs from different microbes and the temperature changes that may be seen in the composting material. In large scale operations piles of 'mature' compost can retain very high temperatures due to their insulative properties.

In commercial scale composting systems the temperature timeframes may be considerably longer than suggested Figure 1. The time periods for an individual site will depend on the feedstocks being treated and the process being employed. It is important to understand that these phases will not occur in an inevitable time line. They can occur out of sequence as a result of a specific management regime and feedstock characteristics.

The different anticipated phases of the composting process, as identified within Figure 1 are as follows:

3.2.1 Mesophilic Heating

During the initial phase, the substrate is degraded by a diverse population of aerobic mesophilic fungi and bacteria. These organisms degrade the readily available organic material within the waste (the substrate), creating new microbial biomass from the substrate.

The heat released from this activity raises the temperature of the pile to approximately 45°C and once this temperature is reached the activity from the mesophilic micro-organisms ceases, with many of them dying off leaving only heat resistant microorganisms. The "heat release from mesophiles" curve (shown in Figure 1) gives an **indication** of the relationship between the activity of the mesophiles and temperature. After the first day or so, approximately, the temperature curve increases. This point corresponds to a peak in the "heat output of the mesophiles" curve of approximately 670 cal/h. As the temperature continues to increase the heat output by mesophiles falls. This reduction in heat output is indicative of a reduction in composting activity by mesophiles.

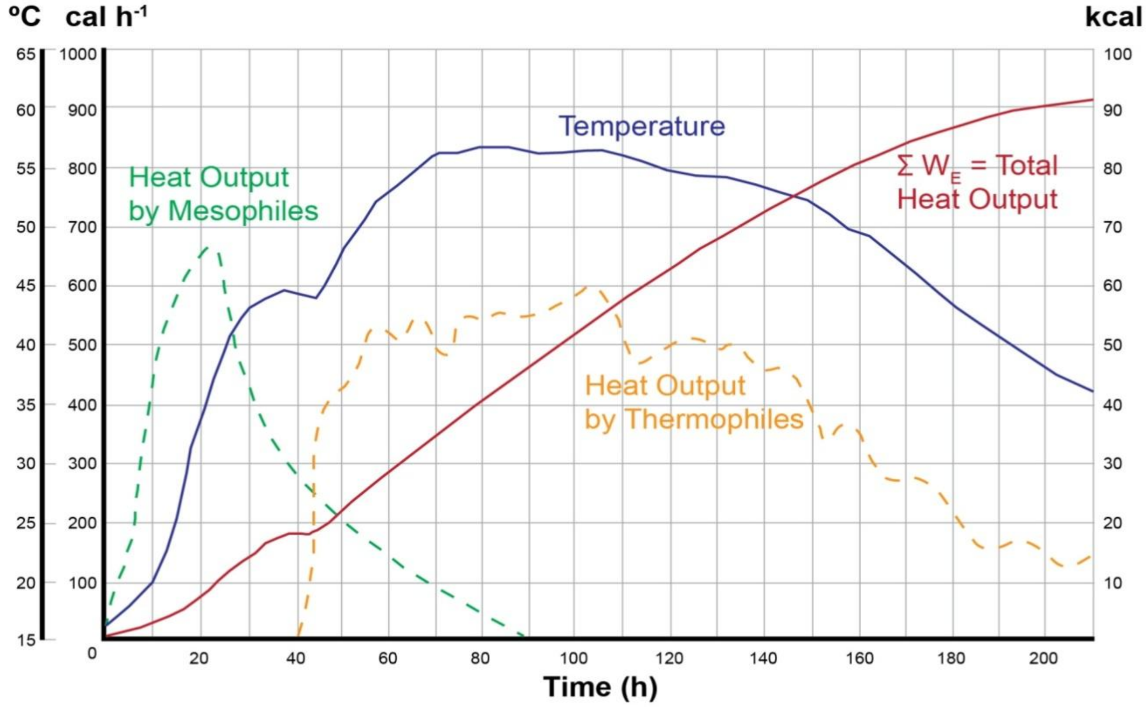


Figure 1: Observed small scale temperature course and heat release during composting (Pöpel , 1971)

3.2.2 Thermophilic Heating

Following completion of the initial mesophilic stage, and the reduction of the associated mesophile population, the pile then becomes populated by thermophilic microbial population of bacteria and fungi, which tolerate and thrive at higher temperatures. There may be a short lag phase whilst this population develops. This population causes another rise in temperature, the activity of this critical population will cease in the temperature range of 70°C - 80°C. Where temperature profiles are allowed to increase to 70-80°C, the production of NH_3 will be unavoidable and therefore can produce poor organic stabilisation and objectionable odours. Above this temperature chemical decomposition takes place which can produce undesirable malodorous materials and increase the risk of fire. Figure 1 shows the slight lag time by a levelling of the temperature. Heating of the mass is then re-established and the temperature increases up to 55°C, with the optimal temperature for thermophilic organisms being in the range of 55° - 60°C, however this may vary with the individual feedstock being treated.

There are variables in this stage of the process that can adversely affect the rate of thermophilic heating. These are generally related to the system used and feedstock, where waste with readily available sugars, starches and simple proteins will break down more readily causing a rapid rise in bacterial activity and therefore heat output. This is covered in more detail in section 5 (Treatment principles).

3.2.3 Thermophilic Steady State

Following the increase in temperature to a recommended 55-60°C, the next phase is a relatively static period where the heat released by thermophiles and the pile temperature reaches equilibrium. The temperature should therefore remain relatively constant. The microbial population at this point continues to be formed of thermophilic bacteria, actinomycetes (which are seen as white filamentous coating on the compost) and fungi. In Figure 1 this phase continues and will vary according to the processing system used and feedstock characteristics.

3.2.4 Reduction in Activity and Cooling

Finally, there is a reduction in activity as the volatile components (the readily available organic part of the substrate) are used. This final phase is often referred to as the maturation phase. The rate of heat output from the degradation of available material is less than the heat loss from the system, resulting in a reduction in temperature.

As the temperature typically drops below 45°C, mesophilic micro-organisms become re-established from spores and bacteria that have survived the thermophilic process. Other methods of pile reestablishment are from new ‘seed’ organisms that are introduced to the composting mass, for example, from external windblown bioaerosols or from mixing in additional active feedstock. Finally, the mesophilic population succeeds the thermophilic population and continues the degradation and maturing process. A summary of the temperature profile is shown in Table 3.

Summary expected temperature profiles	
Ambient – 45 degrees Celsius	Mesophilic activity
45-70 degrees Celsius	Thermophilic activity
45-60 degrees Celsius	Thermophilic and gradual re populations, actinomycetes increase
45 degrees Celsius	Increased colonisation of mesophiles

Table 3: Summary of expected temperature profile

A simplified representation of the composting process is:

carbon source + nitrogen source + oxygen ⟶ microbial biomass + carbon dioxide + water

In a well-managed process, with aerobic conditions throughout the waste mass, any excess nitrogen will become released as ammonia and will be ultimately oxidised to nitrate. The pH conditions in the waste mass will retain ammonia in the aqueous phase as ammonium. pH is a significant factor in determining the proportion of ammonia and ammonium. As pH increases so will the proportion of ammonia. This demonstrates the importance of feedstock management and effective composting in the prevention of odour arising from ammonia.

When very high temperatures or anaerobic conditions are allowed to develop in the waste mass, through poor design and/or operational management, this may result in poor organic stabilisation and an accumulation of ammonia. This may lead to health and safety issues for operational staff, producing poorly stabilised humic material and the release of offensive odours.

By considering the representative make up of a feedstock, it is possible to estimate the required oxygen supply and to determine the likely overall heat output. The material properties of feedstocks (moisture content and C/N ratio) are provided in Appendix 12.1. These parameters should be considered in the design of infrastructure on the site, such as the use of aeration systems to maintain aerobic conditions throughout the compost pile. Ventilation of air through the compost material helps to control composting temperature, maintain aerobic conditions.

3.3 Kinetics and Inhibition

Microbial activity within a compost pile is influenced by the following factors:

- moisture content;
- pore space;
- oxygen content;

- process temperature;
- nutrients (C/N ratio, micronutrients, availability); and
- pH.

The microbial population within the composting matrix will continue to grow until one or more of the above factors becomes limiting.

3.3.1 Moisture Content

Moisture supports the metabolic processes of the micro-organisms. Water is the medium for chemical reactions, transportation of nutrients and allows transport of micro-organisms. Biological activity significantly reduces or ceases below 15% moisture content and in theory activity is optimal when materials are saturated. However, the principal source of the oxygen for microbial populations is the air trapped in the voids between the substrate particles. The moisture content depends on the feedstock (e.g. particle size and degradability). Feedstock material such as fruit waste, sludges or grass clippings tend to have a smaller particle size and lower porosity. Bulky and woody garden materials such as hedge trimmings and tree cuttings have much higher porosity due to their larger particle size and in mixture can provide a good balance of porosity and with small particle materials. Some consideration should be given to the nutrient content when blending materials; further information is provided in section 3.3.5. This effects the rate of distribution and moisture oxygen transfer, the composting system being used and the stage of composting (Richard et al., 2002).Maintaining the correct moisture balance requires proactive management of the material throughout the process.

Without sufficient moisture to form a moisture film on the particle there will be very low levels of microbiological activity. A <40% value would be limiting to biological activity, which in itself could give a false impression of stability of the compost. Drier material will also give rise to high levels of bioaerosols, dust and a potential risk of fire from ignition sources or spontaneous combustion.

Moisture content should be above 40% at the starting point and will generally decrease as composting proceeds. Therefore if the moisture content falls below 40%, more should be added to maintain optimum conditions.

A moisture content >65% water will displace much of the free air space in the pore spaces within the composting matrix, which will become blocked with moisture or compacted material, thereby limiting the mass transport of oxygen. This further reduces microbial activity and can lead to the development of anaerobic conditions. If an operator is considering composing a wet waste on an external pad then they will need to ensure that their infrastructure is appropriate: ie drainage and collection and the porosity is assessed and corrected.

The optimal moisture content will vary depending on the feedstock and composting system being used. However, a moisture content range of 50% to 60% (wet basis) is considered the optimum content for the majority of materials, depending on the particle size, degradability, stage of composting and management regime. Wet waste will need to be blended to allow adequate porosity in the waste mix at the preparation and this may need further adjustment during processing.

During normal operations moisture should be monitored and adjusted as necessary. The need to adjust feedstock's moisture is determined by monitoring and assessment during preparation and processing. Initial correction of moisture should be done as waste is prepared and for in vessel systems, prior to the vessel loading. Based on monitoring and assessment, moisture is further adjusted during the process. This is usually done as waste is transferred from first to second barrier or when waste is unloaded from in vessel system. In open systems moisture can be adjusted at the start of feedstock preparation or during turning e.g. using a mister or atomiser to ensure even distribution.

An in vessel system should offer a greater level of control over the treatment of wetter wastes and allow for the collection, treatment and disposal of excessive moisture (condensate) and leachate.

Further detailed information on the relationship between air space, temperature and moisture will be published in early 2014.

3.3.2 Pore Space

Pore space or porosity refers to the void space within the composting material. Pore space is important as the principal source of the oxygen required by the microbial population is the air trapped in the voids between the substrate particles. The majority of aerobic decomposition occurs on the surface of particles. The reaction is at the solid/liquid interface and it is therefore necessary to transport oxygen to that point. Oxygen moves readily as a gas through pore spaces, but moves more slowly through liquid and solid phases. Therefore, the movement through the liquid phase has the potential to limit the process.

Insufficient pore space will impede the process through insufficient mass transfer of oxygen, carbon dioxide and off gases. Pore space can also become clogged with moisture, diminishing the effective pore space. However, pore space can be restored within a composting mass through additional bulking agents, turning or agitation.

The relationship between moisture content, available pore space and availability of oxygen can be represented by the term “tolerable moisture content”. Moisture is produced as materials degrade, moisture removal is provided by airflow through the compost and this would be impeded by low permeability, which is related to (smaller) particle-sized material.

This may be affected by physical characteristics of the composting material. Tightly packed particles and feedstock materials, such as layered and wet paper and card, allow pockets of stale off gases to develop and prevent the circulation of air. In these situations anaerobic conditions can develop. The photograph below Figure 2 shows packed wet and dense material that may give rise to reduced diffusion of oxygen in the mass of materials.

The physical structural properties of the raw materials can therefore affect the composting process. Feedstock must be adjusted by selection and mixing to provide optimum conditions for composting. Any materials added to adjust these properties are often referred to as bulking agents. The blending of feedstock can aid the distribution of particle size prior to shredding, and so aid aeration and air distribution.

Figure 2: Densely packed material and poor diffusion of gases

3.3.3 Oxygen Content

As the process is aerobic it will require an effective supply of oxygen throughout the composting process. Oxygen uptake and depletion will be caused by microbial activity, however in some circumstance poor management, may lead to elevated temperatures and depleted or challenged microbial populations. The availability of oxygen for microbes will be influenced by certain parameters such as high temperatures and moisture content. In these conditions excessive supply of oxygen may lead to chemical oxidation of the substrate (smouldering); appropriate assessment and corrective control strategies should be undertaken to prevent and mitigate against this conditions developing. . Other parameters such as wet/dense or small particle sizes (e.g. fig 2) will require management methods to allow the supply of appropriate quantities of oxygen throughout the compost mass.

3.3.4 Process Temperature

The optimum temperature range for thermophilic populations is 55°C-60°C, as at about 60°C some beneficial micro-organisms start to be killed. For mesophilic populations the optimum temperature is in the range of 35°C to 45°C. These are typical optimums as there may be combinations of microbial species and feedstocks that have optimums outside of these ranges.

3.3.5 Caron Nitrogen Ratio and Nutrients

A volatile solids content of at least 40% dry basis is needed for the material to be suitable for composting. Volatile solids are that fraction of the total solid which is organic and that can be treated biologically. It is important for the volatile material present to be biodegradable.

Nutrients can be grouped into the categories “macronutrients” and “micronutrients”. The macronutrients include carbon (C), nitrogen (N), phosphorus (P), calcium (Ca), magnesium (Mg) and potassium (K). Among the essential trace elements are manganese (Mn), cobalt (Co), iron (Fe), and sulphur (S). Most trace elements have a role in the cellular metabolism.

Organic carbon within composting feedstocks provides energy and acts as a substrate for biomass growth. However metabolism cannot occur without a range of macro and micro nutrients, the most important of which is nitrogen. The most common descriptor of nutrient availability in composting is the carbon to nitrogen ratio (C/N ratio) as this ratio indicates the availability of nitrogen within the feedstock. Other macro nutrients include phosphorous and potassium.

Many elements are also required in lesser quantities within feedstocks and are termed micronutrients. Among the essential elements are calcium (Ca), magnesium (Mg), manganese (Mn), cobalt (Co), iron (Fe), zinc (Zn) and sulphur (S) and these elements have a role in the cellular metabolism. Within mixed complex feedstocks (food wastes and other organic matter) there may be adequate availability of these trace nutrients. Other feedstocks may be deficient in one or more and this will lead to inhibition of the composting process. It is also important to recognise that micro nutrients may themselves inhibit the composting process at relatively low concentrations.

Nitrogen is used by micro-organisms for protein manufacture and reproduction. Carbon is used for energy and growth. Generally speaking, biological organisms need about 25 times more carbon than nitrogen. This ideal C:N ratio of 25:1 is not found in any one organic source and although a useful operational benchmark, in itself it does not confirm the presence of sufficient macro and micro nutrients. The carbon and nitrogen in organic materials may not always be readily available to microbes. The failure of a material to decompose, or slow decomposition, may be due to the absence of a specific nutrient. The carbon and nitrogen in organic materials may not always be readily available to microbes and so the operator should understand their feedstock and the forms of carbon and nitrogen and where necessary the availability other macro and micronutrients.

In general, the combination of feedstock quality and compost process management will determine the quality of the finished product.

Carbon is often present in green waste collections and is much harder for microbes to access than the nitrogen. The complexity of the carbon compounds also affects the rate at which organic wastes are broken down. The ease with which compounds degrade generally follows the order:

carbohydrates > hemicellulose > cellulose > chitin > lignin.

Fruit and vegetable wastes are easily degraded because they contain mostly simple carbohydrates (sugars and starches). In contrast, leaves, stems, nutshells, bark and trees decompose more slowly because they contain cellulose, hemicellulose and lignin. Therefore, residence time and decomposition rates will vary.

Cellulose is the structural component of the primary cell wall of green plants, many forms of algae and the oomycetes. Some species of bacteria secrete it to form biofilms. About 33% of all plant matter is cellulose (the cellulose content of cotton is 90% and that of wood is 40–50%).

Lignin is present in some plants and has the potential to significantly impact on the biodegradability of a feedstock. Lignin is one of the most slowly decomposing components of dead vegetation, contributing a major fraction of the material that becomes humus as it decomposes

The rate at which carbon compounds decompose must be considered in planning site operations. If the carbon is in the form that is difficult to decompose, for example large wood particles, the composting rate may be slower (e.g. wood wastes). Since decomposition occurs on particle surfaces, degradability can be improved by reducing the particle size as long as porosity is not compromised.

Raw materials mixed to provide a C:N ratio of 25:1 to 35:1 are generally accepted as ideal for active composting, although ratios from 20:1 up to 40:1 can give good composting results. The carbon should be readily biodegradable, for example lignin is resistant to biological decomposition but contains carbon, this carbon is likely to remain bound up through the typical composting process and residence time.

Low C:N ratios of below 20:1 allow the carbon to be fully utilised without stabilising the nitrogen, which may be lost as ammonia gas or nitrous oxide(especially when the temperature rises and the pH is higher than 7.5) possibly resulting in odour issues. High nitrogen, low carbon feedstocks have a rapid oxygen consumption and these feedstocks require almost constant and vigilant management as the temperature changes and processing are rapid. The feedstocks are also generally more compact and this makes any aeration problematic, which can also cause odour problems.

Ratios of composting materials with a carbon content higher than 40:1 require longer periods for the excess carbon to be used by micro-organisms and for the material to be stabilised. Table 4 summarises the C:N ratios for composting.

Carbon	Nitrogen	By- Product	Potential risk/problems
<20	1	Excess nitrogen may give rise to ammonia and loss of nitrogen	Off site odour – shock loading in biofilters
> 40	1	Slower rate of composting	Prolonged pad residence and over tonnage at site. Risk of fires increased

Table 4: Optimal C:N ratios for rapid, aerobic composting (Adapted from Rynk, 1992)

3.3.6 pH

pH level usually drops at the beginning of the compost process. The initial drop reflects the synthesis of organic acids. The acids serve as substrates for following microbial populations. As the pH rises, it reflects the utilisation of the acids by the microbes. Most bacteria will not survive at a pH of 3 or below. Similarly, most bacteria begin to lose activity at pH levels above 10.5, with significant kills above ~pH8.9. Although this range is within the pH criteria for non-hazardous wastes, it is important to note that there will be reduced microbial activity at these extremes. The range in which bacteria can function best is 5.8 to 7.8.

Composting has some buffering capacity for both alkali and acid wastes. This is due to the production of carbonic acid, a weak acid formed by CO_2 in solution and of ammonia, a weak base. High pH materials will need to be treated or blended to adjust their pH or the process will encounter an extended lag phase before composting occurs. In low nitrogen, low pH materials there may be insufficient ammonia to bring the material to a favourable pH. These situations can occur more frequently where novel wastes are accepted and is not best practise for creating ideal composting conditions therefore it may be necessary to manage this feedstock by blending with additional appropriate material. A summary of the process inhibitors are provided below Table 5

Inhibitor	Description	Optimum conditions
Lack of oxygen	A lack of oxygen can slow down the composting process. In addition, this can lead to anaerobic conditions which results in the generation of malodorous compounds such as methane, organic acids and hydrogen sulphide.	>5%
pH	During the initial stages of decomposition, organic acids are formed that are normally consumed by aerobic micro-organisms. As oxygen supplies in the pile decrease, these acids will not be converted as quickly and pH levels may drop below 6. Overly high alkalinity can cause the release of unpleasant smelling ammonia gas and also inhibit microbial activity.	5.8 - 7.8
Temperature	Temperatures higher than 70^{o}C result in the retardation of most microbial activity and release of odour and bioaerosols.	40^{o}C – 60^{o}C
Light metal ions	High salt levels cause bacterial cells to dehydrate due to osmotic pressure. Light metal ions including sodium, potassium, calcium, and magnesium may be released by the breakdown of organic matter or added as pH adjustment chemicals. They are required for microbial growth and, consequently, affect specific growth rate like any other nutrient. While moderate concentrations stimulate microbial growth, excessive amounts slow down the growth, and even higher concentrations can cause severe inhibition or toxicity.	Significant variations are reported in toxicity levels for light metal ions.
Heavy Metals	Heavy metals identified to be of particular concern with regards to inhibition include chromium, iron, cobalt, copper, zinc, cadmium, and nickel. A distinguishing feature of heavy metals is that, unlike many other toxic substances, they are not biodegradable and can accumulate to potentially toxic concentrations.	see assessment and inhibition vales in Assessment of novel waste streams document [link]
Particle size	Particle sizes which are too small can lead to compression and settling of the feedstock which reduces the porosity of the material and can inhibit the movement of moisture and air through the material., larger particles can diminish surface area and may therefore slow the composting process.	10mm – 50mm
Ammonia (NH_3)	The main issue associated with an incorrect C:N ratio is the potential release of ammonia odours as a result of high nitrogen levels which readily consume the available oxygen	C:N ratios of 20:1 – 40:1
Moisture	Moisture content is important to maintain micro-organism activity; low moisture content can lead to micro-organisms becoming dormant. If the moisture content becomes too high the porosity of materials is reduced and anaerobic conditions can flourish within the composting material.	40% – 70%
C:N ratio	Incorrect mix of Carbon: nitrogen ratio may cause delayed of unstable processing	See table 4 and Appendix 1

Table 5 Process inhibition and optimisation parameters

3.4 Process Configuration

Typically, the phases of composting at a site consist of:

- Pre-processing;
- Sanitisation
- Stabilisation
- Curing/maturation; and
- Post processing storage

3.4.1 Pre-processing

Pre-processing usually consists of reception and storage, shredding, blending of materials and/or amendment of moisture balance. To effectively manage odour best practice is to manage waste materials before they are received at the site by having a clear understanding of feedstock quality and properties. This is difficult where contracts take kerb side collected waste which may present waste in an advanced stage of decomposition. The amount of decomposition will depend on factors such as collection frequency and source.

Particular attention needs to be paid when wastes are bulked up at transfer stations. Where waste is ‘fresher’ there is generally less likelihood of odours. Best practice should see waste operators actively auditing upstream feedstock suppliers.

Once accepted on site, materials should be processed within 24 hours to avoid uncontrolled decomposition of the waste. Where this is not possible then the feedstock must be managed to maintain aerobic conditions, for example through the use of aeration. The site must develop contingency to divert wastes when unable to process them quickly. It is recommended that waste is not stored longer than 5 days prior to processing.

3.4.2 Sanitisation

As previously discussed in Section 3.2, the sanitisation composting phase is characterised by an increase to thermophilic temperatures (55° - >60°C), high oxygen demand and high reductions in volatile solids.

The sanitisation period depends on the feedstock material being treated, the process that it is subjected to and the management by the operator. Many in-vessel systems were originally developed to more effectively manage the material and improve the process control during the composting process. However, subject to Animal Health & Veterinary Laboratories Agency (AHVLA) approval, these systems are mainly used in the UK for the sanitisation phase required for material subject to the Animal By-Products Regulations (ABPR).

Influencing factors such as the requirement for enclosure, low gate fees and high capital costs have led to in-vessel residence times being restricted to meet the minimum requirement of ABPR. This will often not be best practice as the waste should be kept in vessel until the sanitisation stage is complete.

3.4.3 Stabilisation

Once the sanitisation stage has been completed to eradicate pathogens and kill weed seeds, the waste will continue to be highly biodegradable. A further period of active composting is required; this stage is known as stabilisation. This is commonly at thermophilic temperature of approximately 55-60°C. However, lower temperatures have been demonstrated to increase the rate of decomposition.

Stabilisation is the process of biological activities combined with the other conditions within the composting mass, which gives rise to stable compost.

The compost is said to be stable when microbial respiration will not significantly resurge under altered conditions e.g. changes of moisture, oxygen levels or temperature. The rate of carbon dioxide and heat release decreases with increased stability.

The stabilisation period will typically last between 1-12 weeks depending on the feedstock and the time spent in the sanitisation phase. The degree of stability is related to the intended end use of the compost i.e. horticultural end uses require a greater degree of stability, as less stable material may contain phytotoxic substances which are problematic for seedlings and may become odorous in storage. Determining the degree of stability is still a developing scientific area and operators should consult with the end markets and users to agree a mutually agreeable test method and acceptance level.

Material that requires further stabilisation for end market will still require active management. Less stable material will have a higher risk of producing odours, leachate, dust, and bioaerosol release. This need consideration and management where material are stored and in compliance with relevant objectives. For more information on safe storage please refer to How to comply with your land spreading permit (Appendix 12.4).

3.4.4 Curing/Maturation

Once the majority of the easily digestible organic material (available carbon and nitrogen) has been used up, the rate of heat produced will decrease and the material will move into the curing/maturation phase. During this phase the oxygen demand is reduced and temperatures will be approximately 35° - 45°C, the material will continue to cool to temperature approaching ambient levels. The soluble carbon may not be fully used and material is still undergoing treatment at this stage. Additionally, excess ammonia levels should reduce as it is oxidised to nitrate and reactions take place increasing the level of nitrate within the compost; this stage will also need to be managed to prevent odours, dust and bioaerosols. There is also a residual risk of reheating and leachate breakout.

3.4.5 Post Processing

The post processing phase generally involves a combination of screening, blending and bagging to produce a quality, saleable product. The timing and processing will depend on the requirements of the finished product markets. Post screening the material may continue to experience elevated temperatures. This may be due to several reasons, such as the initial temperature of the material, reduced airflow and therefore reduced rate of cooling of the material, the insulating properties of the compost, or continual microbial activity. If the material becomes malodorous and difficult to manage then it is likely that it has been screened too early. However in many cases these elevated temperatures may have no significant negative effects. It is suggested that post-processing heaps are monitored for surges in temperature and managed to prevent pollution.

3.5 Process Types

There are many different composting processes and classification methods for composting. One classification system is shown below in Figure 3. However, the fundamental aims and process controls of the process remain the same irrespective of system applied. The bottom row of the diagram in Figure 3 shows increasing technological intervention moving from right to left, with enclosed or in vessel systems, non-aerated piles on the right to rotating drums on the left. For example an open windrow would be classed as open semi dynamic system. The major differentiator is whether or not the site is enclosed. Other differences include the approach to aeration and agitation of the material to improve mass transfer. There are numerous approaches to composting and various subtleties between different and similar systems. The descriptions given here provide general outlines, but it is likely to be necessary to consider an individual operator's process. This is discussed further in Chapter 5.

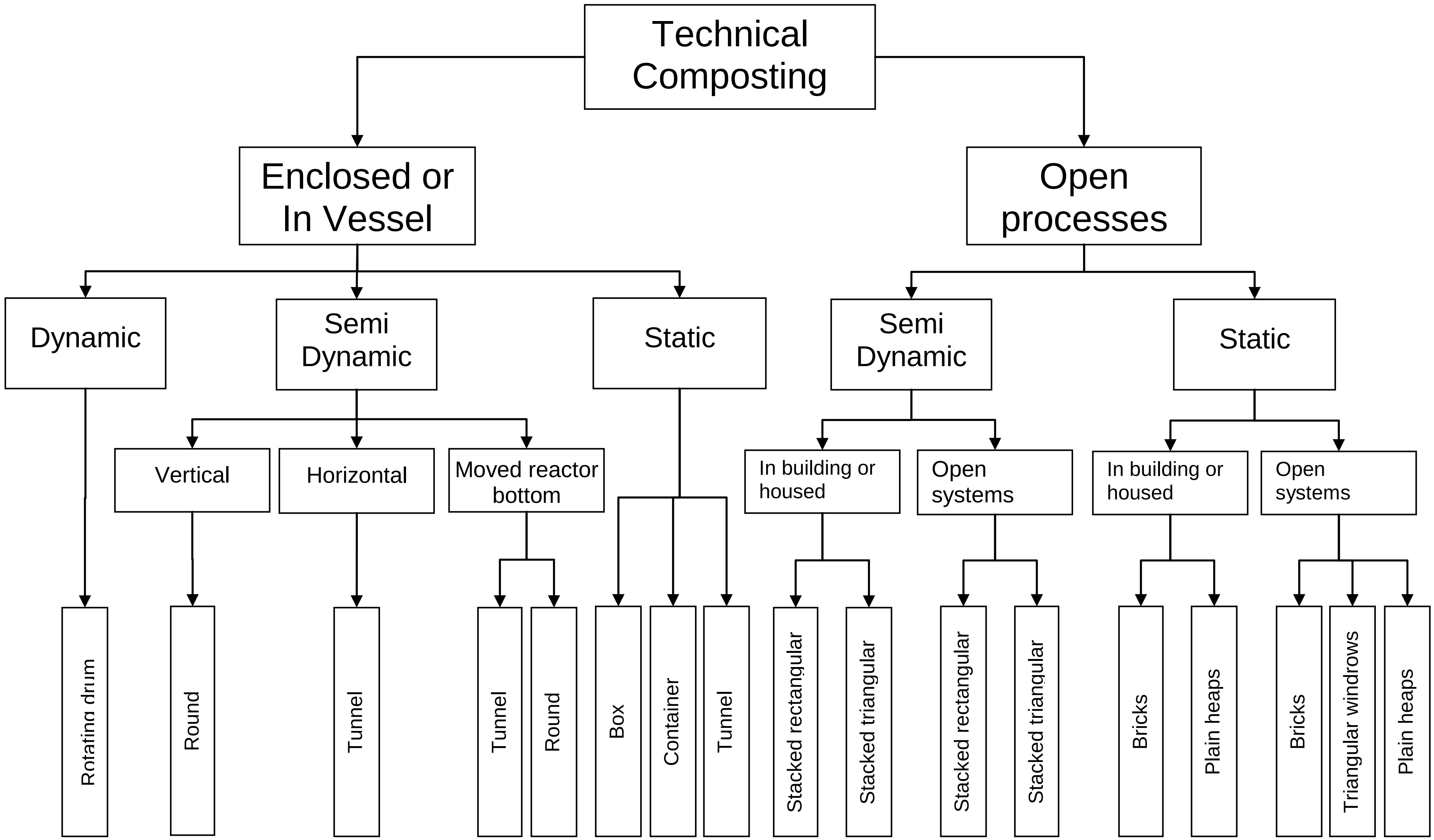


Figure 3: Adapted Hierarchy of Composting Systems (After Grüneklee, 1998)

3.5.1 Enclosed Composting Vessels

Reactor based or enclosed composting, encloses the composting process. Depending on site design this provides opportunity for a significantly greater degree of control over the process. Reactor systems require a greater degree of infrastructure than windrow composting. In England and Wales reactor or enclosed composting is commonly used to provide treatment for animal by-products. Most involve a short period of reactor sanitisation followed by treatment in an open windrow.

Enclosed systems can be divided into 6 types, namely:

- Containers;
- Tunnels;
- Rotating drums;
- Silos or Towers;
- Enclosed halls; and
- Agitated bays

Containers, tunnels, rotating drums and silos or towers are individually contained processes in a building. Whereas, enclosed bunkers, halls and agitated bays are in individual units. All are in a building that contains the emissions and has the capacity to treat emissions produced from the process.

Fully enclosed systems are typically referred to as in-vessel composting (IVC).These generally require less land space than an open windrow plant. When estimating the required area for the composting of 60,000 tonnes per year, an open windrow plant is approximately three times the size of the in-vessel composting plant. However, most in vessel systems are primarily used for sanitisation to meet ABPR requirements of waste only, so additional space may be required for stabilisation and maturation, often in the open. The high temperatures do not allow significant stabilisation to take place and waste may emerge with even higher degradation and require aggressive active management.

Some further detail on various in-vessel composting systems configurations, capacity and designs are available from the Organics Recycling Group (ORG) document “A Guide to In-Vessel Composting” (2004). Operators need to be aware of the systems optimal operational requirements to manage and sustain aerobic conditions.

3.5.2 Emission Abatement

The principal output from the composting process is the composted material itself. Additionally there will be leachate, gases, dust and bioaerosol emissions and low grade heat. Further information on emissions is provided in Chapter 7 which also discusses monitoring methodology and abatement techniques. A diagram illustrating the inputs and outputs of a typical composting process is provided in Figure 4 below.

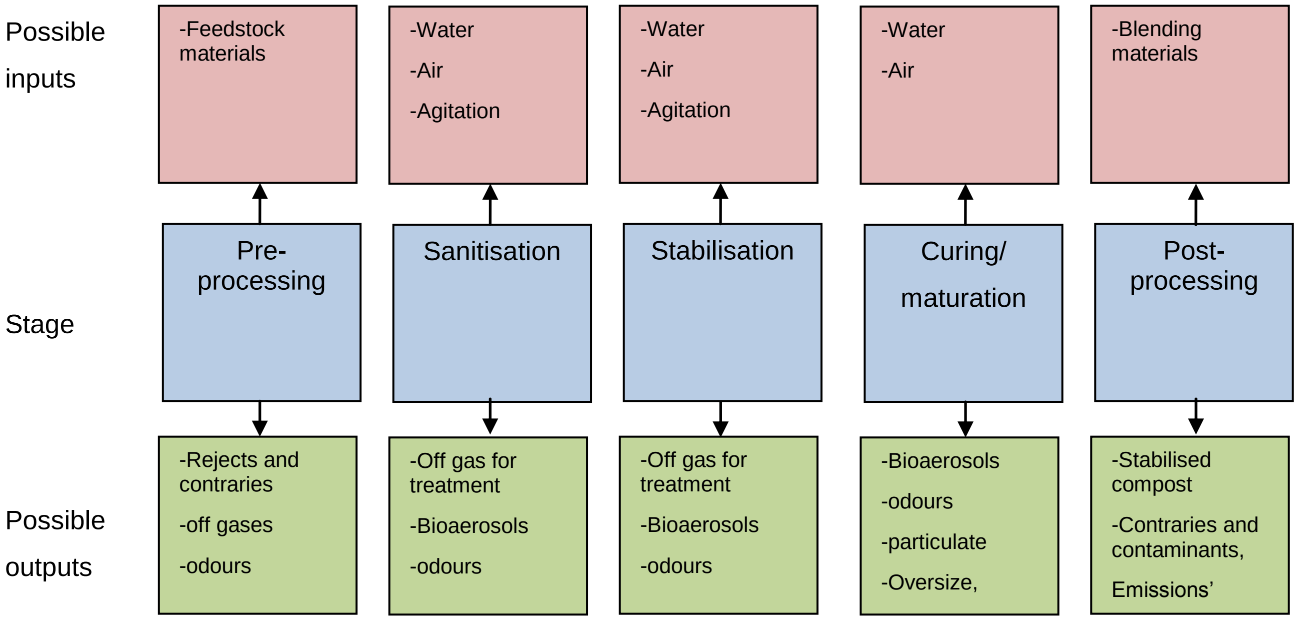


Figure 4: Typical inputs and outputs in a composting process

3.5.3 Monitoring and Control Considerations

A suitable monitoring system, both manual and instrumental, is essential to ensure a stable composting operation. Correct interpretation of data and corrective management will minimise operational difficulties, such as anaerobic areas within the waste, which may lead to odour and unsanitised or unstabilised material.

The key factors to be monitored during the composing process itself include:

- Temperature and temperature distribution
- C:N ratio and other nutrient and key feedstock data
- Moisture of feedstock
- Malodorous feedstock
- Small particle size
- Oxygen and aeration
- Control of contamination risk

The BSI: PAS 100 standard provides a documented guide and system for the control of process parameters. It introduces Hazard Analysis and Critical Control Point (HACCP) as a system to ensure that production parameters are met. HACCP analysis and monitoring is also required for compliance with ABP Regulations where ABP material is processed. HACCP analysis is required and the approach approved by the regulator prior to accepting and processing ABP material on site. Whilst we recognise not all facilities will wish to be certified under PAS 100 and a quality protocol scheme, adoption of a risk management methodology like HACCP or HAZOP are considered best practice.

The general procedure of HACCP analysis requires the operator to:

- Conduct a hazard analysis;
- Determine the Critical Control Points (CCPs);
- Establish critical limits;
- Establish a system to monitor control of each CCP;
- Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control;
- Document and record all procedures, corrective actions and verification results; and
- Establish procedures for verification, audit and review to confirm that HACCP is working effectively.

During design and commissioning, the operator should define the suite of indices that will be used to determine and monitor process performance and efficiency. The relevant monitoring parameters should be reviewed and refined during operation of the facility as part of an on-going process of system optimisation.

Table 6 provides indicative parameters and values that are typically associated with successful composting. It should be noted that if ABP material is being treated then temperature and particle size of the feedstock will need to be monitored to ensure compliance with the legislation.

Process parameter	Indicative limit range
pH	5.6 – 7.8
Particle size	10mm – 50mm
Temperature	40 – <70^{0}C
C:N	<20->40 :1
Moisture	40-<70%

Table 5: Process Monitoring Parameters and values that are typically associated with effective composting process

3.5.4 Process Configuration

The typical process stages of a composting or aerobic treatment operation with the principal functions of each step are listed below:

- Feedstock acceptance and storage:
    - To formally accept waste
    - To provide adequate capacity for the feedstock
    - To prevent fugitive emissions
    - To blend feedstock's and balance conditions in the waste to optimise treatment
- Pre-treatment of feedstock prior to composting :
    - To remove unwanted materials and contaminants
    - To physically prepare the feedstock for composting

- Sanitisation :
  - To meet the requirements of Animal By-Products (ABP) Regulations or BSI PAS 100 which in turn can improve quality and certainty of use
- Composting processes:
  - To sanitise and stabilise the feedstock and produce the required outputs for end use
- Storage and utilisation:
  - To prepare, store and utilise the compost output ready for use.

There will also be ancillary processes, such as abatement plant for process and fugitive emissions. These techniques are discussed in detail in Section 7.

Pre-treatment requirements for a MSW stream will differ from pre-treatment for a pure green and catering or food waste streams due to the potential for likely contaminants. The former may require mechanical or manual separation of the packaging for example, from the waste.

3.6 Markets and Outputs

Compost is used as a soil conditioner for agricultural, horticulture and land improvement applications. When used as a soil conditioner, the humic material can increase the water and nutrient retention of soils and provide organic and micronutrients, resulting in increased yields.

4 Waste Acceptance Procedures

This section covers the key issues which are considered best practice for pre-acceptance and acceptance of wastes brought to facilities. This section should be considered in relation to operational management and waste acceptance permit conditions.

4.1 Pre-acceptance procedures to assess waste

4.1.1 Procedures for waste, waste storage, and specific activities for waste treatment.

In order to prevent the acceptance of unsuitable wastes which may lead to adverse reactions or uncontrolled emissions, systems and procedures must be in place to ensure that wastes are subject to **appropriate** technical appraisal. The operator must have an understanding of the differing characteristics of the feedstock materials they propose to accept. This includes seasonal variability. Operators should be reactive to managing certain feedstock wastes to help to limit odour and bioaerosol releases during processing and composting.

Points to consider:

- Co-mingled collections can influence the composting process. For example a high percentage of cardboard and paper collected with green/food waste can result in changes in the carbon to nitrogen ratio and moisture control may be more difficult.

Waste can vary depending on locality and population of the area it is picked up from. Checks in the form of upstream audits are advised before any waste is agreed or accepted. This requires a system that has, as an initial stage, a screening step or pre-acceptance procedure, involving the provision of information and representative samples of the waste. Sampling can be as simple as visual checking or weighing process (where waste is understood such as Standard Rules or CQP agreed waste) or may required a targeted compositional and chemical analysis.

The second stage, when the waste arrives at the site, should serve to confirm the characteristics of the agreed waste, without the time pressure and potential hazard of checking a waste at the gate. A system of diversion should be established allowing for rejection of malodorous waste, and for process maintenance or failure. These points should be considered prior to agreeing contracts.

The Operator must obtain the following information:

- the nature of the process producing the waste, including the variability of the waste
- the composition of the waste and ensure that;
    - a system of representative sample(s) of the waste should be taken from the production process and analysed or assessed.
    - for each new waste enquiry, a comprehensive characterisation of the waste and identification of collection, pre-storage and age of the waste is advised.

This information should be recorded and referenced to the waste stream so that tractability is clear. The information must be regularly reviewed and kept up to date with any changes to the waste stream. Waste characterisation must be completed by the producer and agreed with the operator.

The waste producer has obligations under the Duty of Care requirements to provide information on the:

- composition of the waste
- handling requirements of the waste
- hazards associated with the waste
- the waste's EWC code

This information is required on transfer of the waste from the producer to a third party such as a waste contractor. Experience of this system has shown that reliance cannot be placed solely upon the producer to provide sufficient information. The producer and operator of the receiving site should ensure that reliable and comprehensive information has been provided to determine the suitability of the waste. It is not unusual for the waste producer and the operator to be separated by at least one and in some cases three or four different parties. These may be haulage contractors, brokers and waste transfer operators. Where there is a lengthy chain, information may be lost or inaccurately reproduced. It is advantageous for the number of handlers to be kept to a minimum. This will avoid information loss or misrepresentation.

If waste is not arising directly from the producer, the operator should carefully verify the information received at the pre-contract and pre-acceptance stage, which, in addition to the minimum Duty of Care information, should include the contact details for the waste producer and a full description of the waste as above.

It is advised that a producer visit is undertaken to verification of the written information provided by the producer.

At the pre-acceptance stage, in addition to written information the operator is advised to obtain representative sample(s) of the waste from the production process. Any deviations from this should be fully justified.

Operators should ensure that technical appraisal is carried out by suitably qualified and experienced staff who understand the capabilities, capacity and permissions of the site.

The outcomes of this standard of practice:

- screen out unsuitable wastes
- confirm the details relating to composition, and identify verification parameters that can be used to
- test and verify the waste arriving at the site
- identify any substances within the waste (for example, by-products) that may affect the treatment process
- accurately define any risks exhibited by the waste
- identify any substances within the waste that may be unaffected by the treatment process and which may transfer in an unaltered state as a residue in the outputs
- determine the route and cost of the disposal option identified
- ensure regulatory compliance, e.g. Animal By-Products Regulations
- ensures effective site management and identification of problematic waste streams.

It is advised that wastes should not be accepted at the facility without a clear method or defined treatment and use or disposal route (with a full costing). The holding of waste while attempting to find alternative disposal routes, which results in some long standing accumulations of wastes, must be avoided. These precautions (defined route/treatment method and cost) will need to be in place prior to final acceptance of the waste on-site, not necessarily at the tendering stage.

4.1.2 Records

It is best practise to establish a waste tracking system, which begins at the pre-acceptance stage. A record should be raised with an enquiry (given a unique reference number) which, if the waste disposal enquiry results in waste arriving at site, should “follow” the waste during its acceptance, checking, storage, treatment or removal off-site. If the waste is a regular arising, then the document should be unique to that waste stream. All records relating to pre-acceptance should be maintained at the facility for cross-reference and verification at the waste acceptance stage. The length of time records should be held will be determined by whether the waste is actually delivered to the site or likely to be delivered. Records pertaining to waste delivered to the facility should be kept for a minimum of three years. Batch tracking is requirement for good operational control of the process regardless of the requirements needed to satisfy requirements for PAS 100 and QP.

4.1.3 Feedstock characterisation and sampling procedures

Characterisation of feedstock material provides valuable information to the operator that can be used to monitor and control the process in order to ensure optimal processing. It also allows for a booking process and ensuring the operations on site are not inundated with difficult or for example odour wastes. Detailed feedstock characterisation by sampling and testing should be conducted as part of establishing a supply contract as 4.1.. Periodic sampling as part of a documented sampling plan should be conducted to test for variation and ensure feedstock is consistent with the supply agreement.

This is of specific interest where sites are accepting liquid or more novel wastes for example at TAD plants. This allows increased confidence of the type of feedstock and how specific parameters within the operational capabilities of the process can be managed. The operator should consider that in accepting and processing the waste they will not inhibit the process or generate emissions that cannot be controlled or abated or which may impact negatively on the desired quality of the outputs or end use.

Sampling programmes and procedure can be simple where waste are already well characterised and well understood e.g. green and food waste. More novel, odours or unstable waste will require more detailed sampling processes.

Sampling and testing of feedstock should reflect:

- the nature of the feedstock and how it arises;
- any potential variation within the feedstock;
- inhibitory values of the feedstock and
- the biodegradability of the feedstock.

The number of samples and period of sampling should reflect the short term and seasonal variation in key parameters in order to derive a set of data that are representative of the specific feedstock.

Table 7 lists the characteristics that are required to be tested as part of a detailed feedstock characterisation for solid waste and allows the process to be planned and managed.

Results of detailed characterisation should be analysed to ensure feedstock can be processed at the facility with no negative impacts on operations or the stability of the process. The supply agreement should include details of procedures that will be undertaken to ensure the required feedstock quality is maintained during acceptance contract of feedstock at the facility. This may include periodic sampling of feedstock in addition to the defined acceptance criteria. The required sampling frequency will need to be confirmed based on assessment of the levels of variability associated with a feedstock source. Appendix 12.1lists the feedstock characteristics typical of composting operations.

Characteristic	Description
Particle size distribution and physical contaminants	The solid sample is graded using a specified nest of sieves by mechanical vibration shaking. Physical contaminants include the recognisable fragments of glass, metal, plastic and non-combustibles (stones and ceramics). Refer to BS EN 13041
Total moisture	The test portion of sample is dried to constant mass in an oven at 105 ± 5°C. The difference in mass before and after the drying process is used to calculate the total solids and the water content. Refer to BS EN 13040
Total organic carbon (TOC)	Appropriately prepared samples can be tested using a laboratory based TOC analyser. This will typically be in the form of a dried ground sample. Operators should understand that there is a strong correlation between biodegradability and the lignin content of the compost this can be considered a predominant factor in biodegradation. Laboratory techniques necessary to determine lignin content can be conducted at nutrition laboratories.
pH and alkalinity	pH is measured potentiometrically in the undiluted liquid sample or in a sample/water slurry for semi-solid or solid sample.
Ammonia and Kjeldahl Nitrogen	Ammonia concentrations can be analysed using titrimetric or Spectrophotometric determination The Kjeldahl method is a means of determining the nitrogen content (in organic and ammonia form) of substances. Refer to BS EN 13654
Heavy Metals and Potentially Toxic Elements (PTE)	Heavy Metals and PTE can be determined using Flame Atomic Absorption Spectrometry. Analysis should be based on dry weight. And expressed as mg/kg.

Table 6: Basic characterisation for waste acceptance.

4.1.4 Indicative BAT requirements for waste pre-acceptance

Indicative BAT requirements for waste pre-acceptance
1 From the waste disposal enquiry the operator should obtain information in writing relating to: • **the specific process from which the waste derives** • **the quantity of waste** • **compositional analysis** • **the form the waste takes (solid, liquid, sludge etc)** • **age of the waste** • **EWC code** • **contingency for dealing with non conforming waste and contingency planning in emergency.** **2 Wastes should not be accepted at the facility unless suitable for composting and aerobic treatment. Biological treatment facilities should be aware that agricultural landbank may not be available for outputs if waste is not fully characterised and alternative disposal routes**

Indicative BAT requirements for waste pre-acceptance
may be needed. **3 The operator should ensure that the sample is representative of the waste and has been obtained by a person who is technically competent to undertake the sampling process.** **4 Where necessary, targeted analysis must be carried out by a UKAS accredited laboratory with a recognised quality assurance and quality control methods and record keeping.** **5 Feedstock characterisation by sampling and testing should be conducted as part of establishing a supply contract. Periodic sampling as part of a documented sampling plan should be conducted to test for variation and ensure feedstock is consistent with the supply agreement. The level of detail will be dependent on feedstock and frequency.** **6 Sampling and testing of feedstock should reflect the nature of the feedstock and how it arises and any potential variation within the feedstock. The number of samples and period of sampling should reflect the set of data that are representative of the specific feedstock. Table 6 lists the characteristics that are required to be tested as part of a detailed feedstock characterisation short term and seasonal variation in key parameters in order to derive optimum processing. More detailed parameters are required for bespoke waste types.**

4.2 Acceptance procedures when waste arrives at the composting and aerobic treatment facility

The control of feedstock quality at a composting and aerobic treatment facility is a critical part of the successful process. It is vital in ensuring that the treatment process operates efficiently and effectively and to maintain consistent quality of the outputs without giving rise to pollution (e.g. odour). Operators should develop procedures to deal with the identification, removal and management of any contaminated material. The removal of contamination is an essential requirement for the production of compost if it is to meet the specification or recovery and suitability for end use.

The bulk of the characterisation work should have taken place at the pre-acceptance stage. This means that acceptance procedures when the waste arrives at the site should serve to confirm the characteristics of the waste. Measures to deal with acceptable wastes arriving on-site, such as a pre-booking system, must be in place to ensure that capacity is available.

4.2.1 Emergency Acceptance

Where facilities provide an emergency service, such as the removal of spillages or diverted waste, pre-acceptance procedures are not always possible. In such instances the operator should communicate the occurrence to the regulator under a schedule 6 notification and quarantine the waste until it is fully assessed.

4.2.2 Indicative BAT requirements for acceptance procedures when waste arrives at the composting or aerobic treatment facility

Indicative BAT requirements for acceptance procedures

All unloading areas should be enclosed with appropriately designed air extraction systems.

<u>Load arrival</u>

The inspection, unloading and sampling areas should have suitably sealed drainage systems.

1 On arrival loads should:

- **be weighed and be accompanied by a transfer notes,**
- **should not be accepted unless sufficient storage capacity exists for quarantine and site is adequately manned to receive waste**
- **all documents checked and approved, and any discrepancies are resolved before the waste is accepted. Waste quarantine procedures to be in place.**

<u>Load inspection</u>

2 Visual inspection should be carried out if safe to do so. Confirmatory checks should be undertaken before offloading where safety is not compromised. Following inspection, the waste should then be unloaded into a dedicated sampling/reception area. Inspection must in any event be carried out immediately upon offloading.

3 The operator should ensure that waste delivered to the facility is accompanied by a written description of it to comply with Duty Of Care. Check every load to confirm quantities against accompanying paperwork.

4 On-site verification and compliance testing should take place to confirm suitability for the site's treatment process.

5 The inspection, unloading and sampling areas should have suitably sealed drainage systems.

6 Wastes must not be deposited within a reception area without adequate space and treatment capacity.

<u>Sampling - checking - testing of wastes - storage</u>

7 All wastes for on-site treatment must be sampled in accordance with the sampling plan and undergo verification and compliance testing.

8 Should the inspection or analysis indicate that the wastes fail to meet the description and or acceptance criteria, then such loads should be rejected or stored in a dedicated quarantine area and dealt with appropriately. Written procedures should be in place for dealing with wastes held in quarantine, together with a maximum storage volume. Non conforming waste should be reported to the Agency. Quarantined waste should be stored for a maximum 5 working days and less if malodours or putrescible waste

9 If the waste is unsuitable for treatment , then the wastes should be segregated to remove risk cross contamination.

10 Tankered wastes should have detailed and targeted analysis sampled prior to acceptance. No mixed tankered should be accepted. There should be no storage pending sampling. Targeted sampling should have been performed by the producer of the waste and the waste fully characterised before delivery.

Indicative BAT requirements for acceptance procedures
11 The waste carrier may arrive at the facility with a sample that has been taken at some stage beforehand. This should be the exception and only be relied on if: • **there are health and safety and environmental control considerations, for example, water reactive substances which would make sampling difficult, and** • **the following written information has been supplied - the physical and chemical composition, incompatible substances and handling precautions, information specifying the original waste producer and process, and** • **the waste has been taken directly from the production site to the waste treatment facility** **12 The facility should have a designated sampling point or reception area.** **13 The offloading, sampling point/reception and quarantine areas should have an impervious surface with self-contained drainage, to prevent any spillage entering the storage systems or escaping off-site.** **<u>Sampling of liquid wastes</u>** **14 Deliveries in bulk road tanker should be accompanied by a "wash-out" certificate or a declaration of the previous load so that contamination and auditing can be monitored and checked.** **15 A sample that is targeted and representative of the waste and takes account of the any variation in the process that produces it should be taken and records kept.** **<u>Drum/IBC sampling and labelling</u>** **16 The contents can only be identified with certainty if every container is sampled. Acceptance should involve sampling every container. However, analysis of composite samples is acceptable with such a sampling regime. A representative sample must be obtained by taking a core sample to the base of the container.** **17 Drummed waste or IBC waste, controls should ensure each drum is given a label to facilitate it's on site storage and further use.** **<u>Waste rejection procedures</u>** **18 The operator should have clear and unambiguous criteria for the rejection of wastes, together with a written procedure for tracking and reporting non-conformance. This should include notification to the customer/waste producer and the Environment Agency. Written/computerised records should form part of the waste tracking system information. The operator should also have a clear and unambiguous policy for the subsequent storage, disposal of rejected wastes. This policy should achieve the following:** • **identifies the hazards posed by the rejected wastes** • **labels rejected wastes to allow proper storage, segregation or disposal** • **alternative disposal arrangements must be in place** • **storage areas should be impermeable and bunded.** **<u>Records</u>** **19 The waste tracking system should hold all the information generated during pre-acceptance, acceptance, storage, treatment and/or removal off-site. Records should be made and kept up to date on an ongoing basis to reflect deliveries, on-site treatment and despatches. The tracking system should operate as a waste inventory/stock control system**

Indicative BAT requirements for acceptance procedures
and include as a minimum: • **date of arrival on-site** • **producers details** • **all previous holders** • **a unique reference number** • **pre acceptance and acceptance analysis results** • **package type and size** • **intended treatment/disposal route** • **record accurately the nature and quantity of wastes held on site,** • **where the waste is physically located in relation to a site plan** • **identification of operators staff who have taken any decisions re acceptance or rejection of waste streams and decided upon recovery / disposal options** **20 All records relating to pre-acceptance should be maintained and kept readily available at the facility for cross-reference and verification at the waste acceptance stage.** **21 The system adopted should be capable of reporting on all of the following:** • **total quantity of waste present on-site at any one time, in appropriate units, for example, 1 cubic meter IBC equivalents** • **breakdown of waste quantities being stored pending on-site treatment,** • **breakdown of waste quantities on-site for storage only, that is, awaiting onward transfer** • **breakdown of waste quantities by hazard classification if applicable** • **indication of where the waste is located on site relative to a site plan** • **comparison of the quantity on site against total permitted** • **comparison of time the waste has been on-site against permitted limit** **These records should be held in an designated area, as agreed with the Agency, well removed from operational activities in a secure place to ensure their accessibility during any emergency** **22 Back-up copies of computer records should be maintained off-site.** **<u>General</u>** **23 Wastes should not be accepted at the facility without sufficient capacity to treat being available. These checks should be performed before the waste acceptance stage is reached.** **24 The operator should ensure that personnel who may be involved in the acceptance, checking, sampling and analysis procedures are suitably qualified to industry standards and adequately trained, and that the training is updated on a regular basis.** **25 Analysis should be carried out by a UKAS accredited laboratory.** **26 Samples should be retained on-site for a minimum of two days after the waste has been**

Indicative BAT requirements for acceptance procedures
treated. **26 Once analysis, in accordance with the sampling plan, has demonstrated the waste is acceptable, the operator should only then create a batch for treatment. Once a batch has been assembled for treatment, the operator should create a composite sample for analysis prior to treatment. Scope of analysis depends upon intended treatment but should be specified. This applies where sites are taking bespoke or liquid waste types - please refer to Framework for assessing suitability of wastes going to anaerobic digestion. Composting and biological treatment.** **<u>Emergency waste acceptance</u>** **27 Where waste is accepted from a third party operation e.g. a site has mechanical or processing difficulties, all information regarding contracts and upstream auditing should be supplied by the third party operator before the waste is accepted on site.** • **The age of the waste should be clearly stated prior to acceptance on site** • **The nature of the waste and process that gave rise to the waste should be given.** • **EWC codes and all transfer notes should accompany the waste and should be on the receiving sites permit** • **Additional clearance may be necessary if the waste contains ABPR waste** **28. Waste should be quarantined and assessed as suitable for the process** **29 If it is found that waste contains contamination or unsuitable waste the operator should remove from site within 5 days.** **30 If waste is assessed as suitable then it should be processed within 48hrs for putrescible or as a maximum within 5 days.**

4.3 Waste reception and storage

Waste feedstock should be processed as soon as possible in order to prevent its unmanaged decomposition prior to composting. This reduces risk of pollution and fugitive emissions. Failure to control and manage materials within reception areas may also result in ongoing problems within the biological process as feedstock decomposes rapidly at ambient temperatures potentially leading to sub-optimal processing conditions.

Storage facilities and procedures must be designed to ensure no cross contamination occurs between inputs and outputs of the process. Each treatment and storage area shall be clearly signed. Process diagrams detailing feedstock storage requirements should be contained within the site management system.

A clearly defined reception area for feedstock that allows assessment of the quality of and any pre-treatment of the feedstock. ABPR waste reception must be enclosed in a building, which is kept under negative air pressure which can reduce fugitive emissions, including noise. Exhaust air from the reception hall should be treated prior to discharge to air. The design must provide adequate space to allow control over waste delivery in order to minimise the amount of time that feedstock is stockpiled before being processed (first in first out).

If a facility is storing liquid or slurries prior to treatment the construction of storage containers or tanks should be fit for purpose and the level of storage must be checked that maintained alarm to detect leakage. All storage areas must be bunded. The Agency will produce standards for primary and secondary containment in 2014.

Where feedstock could give rise to offensive odour, additional agitation or aeration may be required and fitted with an abatement management system.

Storage of feedstocks is an important consideration and can impact both the operation of the facility and the capital cost. All feedstock storage must comply with the requirements of environmental permitting and where required, animal by-products regulations.

The main objectives for the storing of material prior to processing are as follows;

- store the waste safely
- prevent emissions and
- provide adequate contingency storage space.

The key issues for storage are;

- Location on site;
- Storage area infrastructure;
- Condition/containment of containers;
- Feedstock control;
- Building Air Handling/Air Changes;
- Segregated storage of materials; and
- Containment to protect the environment and workers health.
- Prevention of fugitive emissions

Sufficient space should be available to provide safe storage for a short time in the event of an emergency or breakdown. Contingency plans for feedstock acceptance are extremely important in order to ensure feedstock can be diverted if such emergency and breakdowns are prolonged for more than a few days.

4.3.1 Weighbridge / Weighing Facilities

A weighing facility should be available for all sites. Recording of material inputs and outputs is required for permit compliance and customs and excise purposes.

4.3.2 Feedstock Acceptance and Process Areas

It is considered good practice that the facility is designed so that there is a one way flow of material from intake of feedstock to removal of outputs. Where the feedstock includes ABPR waste, procedures must be in place to ensure that unprocessed feedstock cannot contaminate the final output material either directly or via personnel or equipment.

A waste reception area for the feedstock is required to check the quality of feedstock and perform any pre-treatment. The reception area must be designed taking the feedstock properties into account. The reception area must include sufficient space and flexibility to manage changes in the volume and properties of feedstock.

All reception areas should have an impermeable surface with self-contained drainage, bunded or high kerbing to contain liquors and prevent any spillage and escape off-site. The design, subsequent maintenance and repair should prevent the contamination of clean surface water.

Where ABP material is processed, wheel-wash facilities should be provided for disinfecting delivery vehicles on exit from the reception hall. Steam cleaning should be conducted in a dedicated area. All reception areas should have a dedicated cleaning area with dedicated drainage. Additional constraints may apply to wash waters where ABPR waste is processed.

For waste containing animal by products the reception area must be enclosed and vented to an air abatement system. Where sites process green waste or part of the treatment is in the open and is within 250m of human sensitive receptors suggested BAT would be in an enclosed building (this is assessed on site location and risk to sensitive receptors).

Enclosed buildings or vessels must be maintained under negative air pressure in order to minimise odour, bioaerosols and dust release also to reduce noise during unloading, storage or handling operations. The air extraction system should be sufficient to ensure minimum 3 air changes per hour with no dead spaces. Higher extraction rates may be appropriate for certain sensitive locations. Operators should consider the use of air lock entrances at facilities situated nearby to sensitive receptors. Fast acting roller shutter doors are a minimum requirement for allowing access for delivery and other vehicles.

Where waste deliveries are required to be offloaded for inspection and acceptance sampling prior to pre-treatment, the reception areas should be segregated (typically into bays) and managed to ensure waste is not stored for more than 5 days.

Where a bay and equipment are in use regularly i.e. on a daily basis they should be cleaned at least weekly as a minimum.

Should the inspection or analysis indicate that the wastes fail to meet the acceptance criteria, then such loads should be stored in a dedicated quarantine area and dealt with appropriately. Such storage should be for a maximum of 5 working days.

Open processing operations should ensure that all waste acceptance and processing areas are on impermeable engineered surfaces with a dedicated and engineered drainage system. Drainage should be designed with clear segregation and management of clean rainwater and dirty water on site.

4.3.3 Building Ventilation

Compost and aerobic treatment facilities that are required to be enclosed must include a building ventilation system and an odour abatement system. Section 7 provides more detail on the function of the building ventilation system. Further guidance will be available in 2014.

The function of the building ventilation system is to:

- Supply fresh air to working areas and
- Ensure the air in the processing areas is changed sufficiently to ensure smells, fumes and contaminants are removed

Extracted air from buildings with lower levels of odour can be re-circulated within buildings with higher levels of odour. However, concentrated odour air streams should be separated from the diluted odour air streams to enable appropriate treatment. The odour abatement system will be designed and optimised to treat volumes of extracted air to ensure there is no pollution.

Extracted air from buildings, where there is a likelihood of bioaerosols and dust generation, should be processed through a dust filter prior to being re-circulated within other facility buildings thereby preventing high levels of bioaerosols and dust emissions.

Accurate calculation of the air change rate is required and operators should refer to the CIBSE Guide B - Heating, Ventilation and Refrigeration, which provides ventilation rates for industrial buildings and methods of calculation.

The properties of the feedstock such as age and moisture content will also determine the type and capacity of abatement required. Other considerations may be required to prevent unfavourable working and air handling difficulties such as cladding and insulation which can help prevent ‘fogging’ in enclosed processing areas.

4.3.4 Storage bunkers and tanks for sludge and liquid waste

Storage tanks are generally constructed above ground level for ease of inspection and ongoing maintenance. Storage tanks may include a mechanism for aeration and agitation, such as transfer pumps with jetter systems, but mechanical propeller agitation, or forced air agitation may be selected according to the type of feedstock being stored, the planned length of time stored, and the potential for separation and settlement within the stored feedstock. Temperature of the feedstock should be continually monitored and aeration adjusted as required.

Storage tanks should be located on an impermeable surface with sealed construction joints and must provided with appropriate secondary containment that can accommodate a volume at least 110% of the total capacity of the tank. Where tanks are within tank farms the secondary containment should be capable of managing at least 110% of the volume of the largest vessel or 25% of the total tankage volume, whichever is the greater. Any bunds used shall be regularly inspected to ensure that rainwater is regularly emptied and all connections and fill points should be within the bunded area with no pipe work penetrating the bund wall.

Bunkers or tanks that contain odorous or potentially odorous waste should be enclosed or located inside a building and should either be gas tight with air venting, or maintained under negative pressure by air extraction via an appropriate odour abatement system. Where there is ventilation local to the storage equipment this should be managed as part of the site emissions abatement system.

4.3.5 **Indicative BAT requirements for waste reception and storage**

Indicative BAT requirements for waste reception and storage
<u>Reception</u> **1 The reception area for the feedstock/waste should:** • **be appropriately sized to accommodate the expected permitted volume,** • **be appropriate for the properties of feedstock,** • **allow checking of the quality of feedstock, and** • **be able to accommodate basic pre-treatment.** **2 The reception area should allow segregation of Animal By Product Regulations (ABPR) waste and be compliant with these requirements.** **3 Where feedstock deliveries are required to be offloaded for inspection and acceptance sampling prior to pre-treatment, the reception areas should be segregated. Typically into bays or tanks and managed to ensure waste is not stored for more than 5 days. Where a bay is utilised daily it should be cleaned at least weekly.** **4 Should the inspection or analysis indicate that the wastes fail to meet the acceptance criteria, then such loads should be stored in a dedicated quarantine area and dealt with appropriately. Such storage should be for a maximum of five working days, prior to disposal.** **<u>Ventilation</u>** **5 Where the waste reception area is required to be in an enclosed building it will include a**

Indicative BAT requirements for waste reception and storage
building ventilation system and an odour abatement system that maintains the building under negative air pressure in order to minimise fugitive odour, bioaerosol, and dust release from the building. The air extraction system should be sufficient to ensure at least 3 air changes per hour or equivalent, higher extraction rates may be appropriate for certain feedstock's or sensitive locations. Air should be vented to a suitable abatement system. **6 Operators should consider the use of air lock entrances for sites located in sensitive areas.** **7 Fast acting roller shutter doors should be provided for access and egress by delivery and other vehicles which should reduce noise during unloading, storage or handling operations.** **<u>Surfacing and Drainage</u>** **8 The reception area should be designed to facilitate cleaning including drainage to allow discharge of wash waters into gullies and to a sump for use within the process.** **9 All reception areas must have an impermeable surface with self-contained drainage, to prevent any spillage entering the storage systems or escaping off-site. The design should prevent the contamination of clean surface water.** **10 Where ABP materials are processed, wheel-wash facilities should be provided for disinfecting delivery vehicles on exit from the reception hall.** **11 The provision of water and steam should be considered in order to allow for cleaning of vehicles and other transport equipment following delivery. Steam cleaning should be conducted in an enclosed area.** **<u>Storage</u>** **12 Should the inspection or analysis indicate that the wastes fail to meet the acceptance criteria, then such loads should be stored in a dedicated quarantine area and dealt with appropriately. Such storage should be for a maximum of five working days prior to disposal.** **13 Impermeable surfaces and sealed drainage systems should be provided for all areas where waste is stored and/or treated, to prevent contamination from any spillages.** **14 Any above ground tanks used for the storage of sludge or liquid feedstock, digestate or any other liquids whose release could be harmful to the environment must be located on an impermeable surface with sealed construction joints and must provided with appropriate secondary containment that can accommodate a volume at least 110% of the largest vessel or 25% of the total tankage volume, whichever is the greater. Any bunds used shall be regularly inspected to ensure that rainwater is regularly emptied and all connections and fill points should be within the bunded area with no pipe work penetrating the bund wall.** **15 Any below ground tanks or sumps should be constructed with secondary containment and an appropriate leak detection system and must be assessed using H1 and have a maintenance schedule as recommended by manufacturers or installers.** **16 Any tanks that contain odorous or potentially odorous waste should be enclosed/covered and with any venting via an appropriate odour abatement system. Where there is ventilation local to the storage equipment this should be managed as part of the site fugitive emissions abatement system.** **17 Storage areas for drums, bags etc. should be designed and managed with secondary containment to prevent any spillages being released into the environment.** **18 Storage capacities typically need to be designed to ensure continuity of supply over**

Indicative BAT requirements for waste reception and storage
weekends (when traffic movements may be controlled) and holidays. **19 The storage of outputs that are scheduled for spreading to land needs to take into account the closed season for spreading to land and the likelihood of adverse weather conditions that may affect the ability to spread outputs. Storage capacity of outputs needs to take these factors into account.**

5 Treatment - general principles

Ultimately developers and operators risk the closure of their facility if they cannot adequately mitigate pollution. It is therefore important to fully understand the mechanisms and events which during processing cause pollution. A systematic approach should be taken, considering all appropriate measures and giving priority to controls that can be used at the earliest possible stage in the step process. Waste material will be required to be processed as soon as possible to prevent anaerobic degradation or decay which can then result in avoidable emissions throughout composting or processing activity. Waste should be stored for maximum of 5 days using the first in first out principle (FIFO). Many of the parameters for optimising the process have been covered in section 3 of this guidance and need to be monitored and managed during the process.

When producing compost, operators should always be mindful of the end markets/outlets that are being targeted. Quality standards and protocols have been introduced to provide the market with assurances that any risk to outputs are effectively managed and meet stringently controlled process requirements.

5.1 Pre-treatment

The objectives of pre-treating feedstock will typically include;

- Preventing and rejection of malodorous wastes;
- Removing packaging material from food waste (de-packaging) to remove other non-biodegradable material or are not recovered by the process which may impact the quality and use of the compost;
- Rapid processing of waste to prevent or minimise pollution;
- Providing a suitable particle size feedstock for efficient processing;
- Increase the surface area to increase degradation;
- Process improvements such as amending the composting mixture, e.g. amend C:N ratio, moisture levels to optimise the process and reactive management to changing seasonal feedstock;
- Controlling evaporation to minimise surface emissions; and
- Effective containment and abatement and extracting air for odour “filtration”.

Pre-treatment are physical contaminants from feedstock and provides optimal substrate characteristics for effective and efficient processing. How pre-treatment is carried out should be decided at an early stage of the site design and be able to provide flexibility appropriate to process the types of feedstock anticipated to be accepted at the facility.

The following sections provide an overview of typical pre-treatment techniques used in a process. Depending on the facility, a combination of these techniques may be utilised in combination.

Operators should be trained to identify poisonous weeds or invasive species, (such as Japanese Knotweed and Ragwort) which may be found within deliveries to site. The Environment Agency has guidance on invasive non-native species on their website (see links in Appendix 12.4).

5.1.1 Manual Sorting

Manual separation involves a visual examination of the feedstock material by facility staff on a picking line or on the floor of a reception hall. This technique is generally limited to the removal of large contaminants and oversize materials at the reception stage. These will be removed by hand and stored on site for onward reprocessing. Operators should consider the need for manual sorting carefully and should consult the Health and Safety Executive for current best practice on manual handling in order to minimise risks to workers and exposure to bioaerosols.

5.1.2 Mechanical Pre-treatment

Mechanical pre-treatment processes include sorting processes to remove contaminants, reduce particle size reduction and provide mixing / homogenisation. Prior to pre-treating the waste the operator must have an understanding of the process requirements as these vary according to the type of system being used.

Table 8 provides an overview of typical mechanical pre-treatment techniques applicable to a composting and aerobic treatment process.

Equipment Type	Description
Sieving/ screening	Used to separate large particles. Vibrating sieves, static sieves and rotary sieves are used.
Trommel screen	Rotating perforated cylinder used to separate materials by size. Can be used in series with various screen sizes to increase effectiveness of sorting. The screen sizes selected depend on the feedstock delivered and the characteristic required for the composting process.
Bag splitter	Comprises a shredder that generally rotates at a low speed and high torque to split the up bags containing feedstock. This action exposes the waste to the remainder of the process whilst leaving it intact. Rather than send the entire waste stream through the bag splitter the bagged materials are often pulled from the processing line in the pre-sort area and sent through the bag splitter. These materials will then re-join the processing line.
Hammer mill	Method of size reduction consisting of a horizontal or vertical shaft, with mounted steel hammers, enclosed within a casing incorporating a screen. The hammers can be fixed or pivoted where they attach to the shaft. As the shaft rotates, the hammers break-up the material until it can pass through the screen. The number of hammers and size of screen assist in determining the extent of size reduction.
Wet rotating drum with knives	Feedstock is made wet to form heavy lumps of material. This material is then broken up with knives during the rotation of the drum.

Table 7: Mechanical pre-treatment techniques

5.1.3 Food waste de-packaging equipment

Food waste de-packaging equipment is designed to remove non-biodegradable packaging material from delivered food waste prior to digestion.

De-packaging equipment may include elements of the mechanical pre-treatment technology described above and typically includes a bag splitter, a feeding conveyor or hopper and a unit with blades, screws, breaker bars or crushers for shredding and breaking apart the packing material. This is usually followed by a screening stage comprising various screens depending upon the technology, product size and consistency. De-packaging systems may operate by using cylinders or screws that apply pressure and separate liquids/paste from packaging material. The residual packaging may subsequently be rinsed with water to wash any remaining organic feedstock from the packaging material.

Table 9 below provides a summary of de-packaging equipment types and performance as listed on the WRAP food waste de-packaging webpage. Further details and supplier contact details are provided at the WRAP website (see links in Appendix 1). The separation efficiencies listed in Table 9 are the quoted values from equipment suppliers. Practical experience suggests that these are rarely achieved and this needs to be taken into consideration when designing a plant as it has implications on many technical and economic aspects of design and operation.

Equipment Type	Suitable Material	Details	Capacity / Performance
Turbo Separator	Beverages , Biscuits, Baby Foods, Cereals, Coleslaw, Coffee, Custard, Food Tins, Gravy Granules, Household Products, Pasta, Pet Foods	Flanged inlet, variable speed, beater blades and breaker bars. Various screens depending upon product size and consistency.	1-20tph Separation efficiency Up to 99%
Belt / Drum separator	Partly damaged goods, Shelf life expired articles, Packages made of cardboard, paper, plastics, aluminium foil composite film with pasty to liquid contents	Flexible squeezing belt and rotating perforated drum.	Various capacities Separation efficiency ~ up to 97%
Separator	All types of mixed food waste including those packaged in: Plastic Tins Glass bottles	Screw elevator feed. Batch process rotary action, substrate passed through sieves and the plastic fraction is washed before passing through an eject hatch aided by a pulsating compressed air blast. Washed packaging material contains <1% organic fraction.	7.5 to 10 tonnes per hour Separation efficiency up to 95% for mixed packaged waste
Shredder and pulper	Pre-packaged food waste Out-of-date food waste Packaging waste	Slow-running shredders Dissolution of the organic materials in a pulper and separation of contaminants.	Throughput capacity: (15,000 tpa) Separation efficiency (%): 90-95% (in conjunction with Hydro-pulper)
Shredder and screen	Plastic packaging Tins Glass	Feed hopper, 2 screw conveyors, 2 shredders and a separating screen Material sprayed with water. Liquidised food waste runs back down into a hopper, solid waste is discharged at the top into a container.	Throughput capacity (t/h): 4-8 Separation efficiency up to 99%
Screw press	Mixed supermarket waste Liquid and pasty foodstuffs in cans Tetra-pack products Beverages in PET bottles Tinned packaging Dairy and ice cream products	Material fed to screw press via filter chute. Conical outlet remains closed until the internal pressure exceeds the working pressure. Internal pressure drives free liquids/ pastes through perforated screen discharging separated foodstuff into a hopper. Packaging retained and discharged.	Throughput capacity (t/h): 1-3t/h, or 8-12t/h Separation efficiency 70 – 95%, depending on material
Screw press	Filled drinks cans Creamy spray cans Preserving cans/ tins	Packaging presses operate electro-hydraulically. Material fed manually into supply funnel or fully automated via conveyors. Separated liquid	Throughput capacity (m3/h): 2.4 – 17,8 Separation efficiency

Equipment Type	Suitable Material	Details	Capacity / Performance
	Soft packaging PET packaging	collected in large-volume collection trough and discharged by a separate level-controlled pump.	(%): 99
Pulveriser	All liquid filled containers Dairy products Biscuits Cereals Granules (e.g. coffee, sugar, salt and gravy), Pasta, Tinned Foods Cosmetic Items Pharmaceuticals Plasterboards, industrial cake or filter cake	Materials fed into pulveriser via an infeed hopper. Twin 'breaker' shafts comprising multi-blade breaker knives which contra-rotate, pulverising the packaging and releasing the contents against an interchangeable breaker bar grille.	Up to 25 tonnes per hour (dependent upon mix) Separation efficiency up to 99% .
Accelerator	Mixed Food Waste Packed food waste Unpacked food waste Slaughter house waste Food waste and Green waste mixed Energy Crops	Material accelerated within a chamber results in one material hitting another, releasing contents from the packing. Process involves no cutting just acceleration resulting in low operating costs. Packaging and contraries are then removed. Organic fraction is completely broken down with maximum surface area.	4 – 20 tonnes per hour Separation efficiency up to 99% dependent upon down removal
Belt press	Removes foods from their packaging. Handles both cans and plastic packs.	Two stages. Packaging opened and pressed flat in a continuous operation then cleaned in the second stage. Solids in rinsing water circuit removed, packages ejected at the end of the sieve drum. Can be combined with a feeding and discharging facility	Throughput capacity (t/h): 1-7 (tins) Separation efficiency (%): 90-98 depending on feedstock

Table 8: Examples of Food Waste De-packaging Equipment (source: WRAP)

5.1.4 Chemical Pre-treatment

Chemical pre-treatment includes oxidative treatments and the addition of acids or alkalis and maybe used to improve the suitability of feedstock for composting. Strong acids or alkaline chemicals can be used to correct pH imbalance to neutralise material. Chemical pre treatment will involve added complexity to the facility and is liable to require additional measures for sampling storage and recovery.

5.1.5 Third Party / Off-site pre-treatment

Pre-treatment of feedstock material can be conducted off-site from the treatment facility at a third party facility. For example, source separated food waste collected from households accepted at a centralised processing facility, where pre-treatment may include de-packaging, homogenisation and blending. The objectives and requirements for pre-treatment at a third party facility are equivalent to an on-site facility. The pre-treatment facility will require a separate site permit and biowaste material must be transported to and from sites in accordance with Duty of Care legislation and pre-acceptance procedures should apply as Section 4.

5.1.6 Indicative BAT requirements for pre-treatment - general principles

Indicative BAT requirements for pre-treatment - general principles
<u>Pad design</u>
1 The area where open windrow treatment is to take place should be designed with sufficient capacity for waste to be treated within the retention time of the treatment process.
2 Treatment areas should have engineered impermeable surfaces with kerbed areas to allow collection of runoff and leachate as defined in section 2.10
3 Run off and leachate (dirty water) should be collected in an engineered system and collected in a sump or lagoon. Waste containing Animal by products will be subject to additional control under ABP Regs .
4 A maintenance schedule should be included in the management system. Damage and repair that is sufficient to prevent ongoing treatment should be notified.
5 Repair should be initiated within a time frame agreed with the Environment Agency.
<u>Management and Pre Treatment of Wastes</u>
6 The pre-treatment of wastes to remove non-biodegradable material and contaminants from feedstock and also to provide optimal substrate characteristics to enable an effective and efficient digestion process.
7 The objectives of pre-treating feedstock will typically include; • **removal of packaging material from food waste (de-packaging)** • **removal of other non-biodegradable materials e.g. grit & metal** • **providing a uniform small particle size feedstock for efficient composting** • **protecting the downstream plant components that may cause physical damage** • **spare parts should be carried to prevent prolonged down time in the event of a breakdown**
8 Where ABP and non ABP material are processed the facility should allow for both materials to be segregated to prevent cross contamination.
9 Where ABP material is processed, wheel wash facilities should be provided for the disinfection of delivery vehicles on exit from the reception hall. All other cleansing of ABP delivery vehicles should be carried out in an enclosed area. Steam cleaning may be required.
10 Where ABP material is processed, pre-treatment must meet minimum particle size requirements as specified by the ABP regulations • **A discrete quarantine area should be provided for the segregation of unacceptable wastes. Removing materials contrary material from site within 5 days**

Storage of Chemicals

11 Should comply with the COSHH requirements of the specific chemical and stored in appropriate designed containment. All COSHH assessments will be made available on site and be included in the facility emergency plan.

Vessels and pipe work

12 Vessels used for treatment should be equipped appropriately e.g. high-level, temperature and gas pressure monitors.

13 These should be automatic and continuous and linked to a clear display in the control room or laboratory together with an audible and or remote alarm system.

14 Depending on the operational model, location, and manning levels, process monitoring may be interlocked so that, for example, reactor feeding stops when an alarm condition is evident. The detailed requirements for process monitoring, alarms and interlocking should be informed by risk assessment and measures detailed in site management systems (HACCP or HAZOP).

15 Vessels should be fitted with an appropriate mixing/stirring mechanism for the type of vessel and waste to be processed to:

- **ensure efficient mixing.**
- **ensure aeration;**
- **to ensure uniform heat transfer and to prevent sedimentation of silt and stratification in the reactor.**

16 TAD operators should demonstrate that all process equipment including vessels, ancillary pipe work, valves and other mechanical and electrical items and controls are made of materials suitable for each unit operation and to achieve the stated availability and design life of the plant,

Process Monitoring Controls

17 A suitable monitoring system, both manual and instrumental, is essential to ensure stable process operation and to minimise operational difficulties, such as anaerobic conditions which may lead to odour and aesthetic problems.

The key factors to be monitored during the process include

- **Temperature and temperature distribution**
- **Moisture**
- **Further monitoring recommend may also include but is not limited to :**
- **Oxygen**
- **CO_2 / O_2**
- **pH**

18 Monitoring of these parameters requires sampling of feedstocks and waste being processed , at key points in the process. The system design should allow for this. Regular laboratory testing will be required to analyse samples where liquid wastes are accepted and the operator should consider provision for on-site laboratory facilities at large scale facilities

5.1.7 Composting - Open Process Systems

The most commonly encountered form of aerobic composting is open processing. The physical process is relatively simple. Source materials are usually mixed and formed into long piles, known as windrows. The process can be operated in the open or enclosed within a building.

The standard rules permit for composting in open systems states that:

- Permitted waste does not include any catering waste and other wastes containing animal by-products.
- Composting can only be carried out under predominantly aerobic conditions in windrows located either indoors or outdoors. The process should not be carried out under deliberately anaerobic conditions.

5.1.8 Windrow composting without static aeration

Windrow composting is also sometimes referred to as open windrow, open air windrow composting or turned windrows. Windrow composting is usually carried out externally on an impermeable concrete slab with a sealed drainage system.

Windrow composting consists of forming the mixture of raw materials into long piles or windrows, which are turned and re-mixed on a regular basis as conditions dictate. Open windrow composting is not suitable for primary treating materials in accordance with the Animal By-Products Regulations (Enforcement) (England) Regulations 2011. However, it can be used in conjunction with another system, where windrow composting is used as the second barrier for treatment of ABP material. Should this configuration be the process of choice the second barrier must be managed to ensure that this material and its high odour potential are managed effectively.

5.1.9 Size of windrows

Windrows should be appropriately sized so that they allow for the sanitisation and stabilisation of material without giving rise to conditions which could cause anaerobic conditions to develop and subsequently causing pollution. The capacity of the windrow or treatment area needs to be sufficient for the tonnage on site and the residence time required for processing the waste, allowing for machinery access and turning.

The dimensions of a windrow pile are feedstock material dependent and are dictated by the aeration requirements of the pile. The optimisation of aeration depends on the porosity of the feedstock materials.

When determining the appropriate dimensions of a windrow consideration need to be given to the rate of heat generation within the compost, the rate at which heat is lost and the ability of natural ventilation to supply air to the compost.

Anaerobic areas can occur in the material near the centre of the windrow if the pile is too large, and these will release odours and emissions when the windrow is turned. Alternatively, small windrows can lose heat and may not achieve high enough temperatures to kill pathogens and weed seeds and to evaporate excess moisture in the sanitisation phase.

If the windrow is too small then it may not reach appropriate temperatures to allow sanitisation. If the windrow is too large then air will be unable to penetrate sufficiently into the composting mass and may result in anaerobic conditions within the centre. This will result in odours when the material is turned or processed. Large windrows cannot be effectively monitored due to the inability of temperature probes used to measure temperature.

Dense or wet materials should be mixed with larger particles or managed in small windrows, to minimise compaction and allow sufficient passive aeration. Combination with bulking agents such as brash, clean oversize and clean grade ‘A’ woodchip may help open up pore space to allow natural ventilation to provide sufficient oxygen to the core of the windrow and prevent anaerobic conditions from developing. Laying a bed of oversize wood material at the base aids passive aeration and convection through the pile.

For coarser materials, taller windrows may be necessary as the increased porosity may result in a greater heat loss meaning the windrow may not maintain temperatures required for sanitisation. It is suggested that the maximum height for this type of material is no more than 3 meters.

In both instances care must be taken in the preparation of the material into windrows as they will be susceptible to settlement, restricting air flow in the pile potentially leading to anaerobic conditions developing within the pile. Table 9 describes frequently encountered issues with open windrow processing.

Adequate space between windrows is essential to allow passive aeration to take place and to identify and control batches and machinery movement.

	Too narrow	Optimal width	Too wide
Too short	Windrow too small to achieve temperatures required for sanitisation of larvae and weed seeds. Ineffective processing of waste and delayed processing times.	Heat may be lost from the pile too rapidly. Moisture control may become a subsequent issue if not monitored.	Air may not penetrate to the core of the windrow. Causing anaerobic conditions an pollution. Heat may be lost from the pile or insulated causing high temperature profiles Difficulty monitoring representative temperatures Drying of material may occur resulting in bioaerosols where waste is processed at high temperature.
Optimal height	Heat may be lost from the pile too rapidly resulting in delayed or ineffective processing	Optimal composting conditions achieved	Air may not penetrate to the core of the windrow- resulting in reduced aerobic activity at the core
Too tall	Drying of material may occur Heat may be lost from the pile too rapidly Pile sides may be steep resulting in stability issues	Base may be insufficiently aerated Pile sides may be steep resulting in stability issues	Insufficient oxygen reaching core. Requires frequent turning to prevent odorous conditions in core. Dense (e.g. ABPR) waste may not be processed effectively and may cause odours.

Table 9: Windrow sizing trouble shooting

Operators need to be aware that a number of factors need to be considered before selecting a open windrow pile configuration and will need to demonstrate that all parameters are adequately monitored and managed as detailed in earlier sections. Site design and layout should be configured to accommodate changes in feedstock conditions to achieve optimum composting.

In addition to windrow dimensions, operators also need to consider the operational areas that surround the windrows. These areas need to be sufficient to allow machinery to operate and turn windrows without the risk of vehicles driving over composting materials and causing compaction and also cross contamination, adequate areas also allow surface water and liquor to drain away and prevent cross contamination of batches. Please refer to Section 2 - Site Design.

5.1.10 Windrow turning and agitation

Turning should only be undertaken when monitoring the pile indicates its need for restructuring and redistribution this is usually evidenced by temperature, moisture and oxygen monitoring. Turning any other time may cause unnecessary release of emissions e.g. odours and bioaerosols.

Meteorological conditions and location of sensitive receptors are always considered prior to and during activity in order to minimise pollution.

Turning remixes the materials and may re-structure and redistribute the porosity of the windrow restoring the pore spaces eliminated by decomposition and settling. Conversely, excessive turning may reduce particle size and result in loss of porosity and may cause recalcitrant excessive temperatures in the pile.

Turning and agitation allows for the redistribution of settled material and may assist in restructuring of material within the composting mass and facilitate the exchange of gasses, by opening up pore spaces. The activity releases trapped heat, water vapour, dust and organic particulates and gases.

Turning exchanges the material from the interior with the material at the windrow's surface and homogenises the material. Depending on the age of the compost the oxygen introduced through the turning process may be consumed rapidly. Additionally, the agitation may stimulate the process resulting in increased oxygen consumption. Following turning events it has been observed that oxygen concentrations within the waste may fall rapidly before recovering. The rate of recovery is dependent on other parameter such as size and particle distribution, moisture etc being optimised. However, in appropriately constructed and sized windrows the natural aeration should be restored continuing the supply of oxygen to the composting material, by creating a convection 'chimney effect' in the pile structure, drawing air through the bottom of the stack.

Turning method	Advantages	Disadvantages
Windrow turner-straddling	Thorough mixing of compost Assist with physical breakdown of feedstock Allows greater aeration Decreased temperature profiles Generally less odour from material Back acting moisture amendment possible therefore may reduce bioaerosols Reduce staffing requirements Space between windrows well defined allowing passive aeration	Specialist equipment-unexpected breakdowns may result in operational problems. Windrows tend to be small. Particle size usually reduces during processing. Smaller pad area than for tractor drawn turners. Needs larger pad area. Are expensive
Windrow turner-tractor drawn	Thorough mixing of compost Assist with physical breakdown of feedstock Distinct windrow formation aiding aeration May result in reduce bioaerosols Generally decreased odours when allowed to passively aerate.	Specialist equipment-unexpected breakdowns may result in operational problems. Additional space required between windrows for vehicle movements. Lager area required than for staddle turners.
Front end loader	Lower cost than specialised turning equipment Simple to substitute in event of failure	Compost will typically need to be moved into a new area during turning - increased space required for turning. Higher risk thought to be associated with agitation and release of bioaerosols. Less mixing results so than anaerobic pockets may exist in pile.
360 Excavator	Simple to substitute in event of failure Many applications for sites. Improved access to areas not reached by other turners	Driving on top of the pile will result in compaction settlement and reduce the oxygen supply and will result in poorly composted and anaerobic material.

Table 10: Windrow Turning Methods Comparisons

It is important to consider the mixture of the compost feedstock the age and temperature profiling which may influence the type of turner to be used and the frequency of turning. Some equipment used for turning is also capable of applying additional moisture to the process and allows for damping down of particulate as well as moisture addition. Table 10 considers the advantages and disadvantages of differing strategies and approaches taken for turning of windrows.

5.1.11 Indicative BAT requirements for open treatment; general principles

Indicative BAT requirements for open treatment - general principles
<u>Pad design</u>
1 The area where windrow treatment is to take place should be designed with sufficient capacity for waste to be treated within the retention time of the treatment process.
2 Treatment areas should be engineered, impermeable surfaces with kerbed areas to allow collection of runoff and leachate
3 Run off and leachate (dirty water) should be collected in an engineered system and collected in a sump or lagoon.
4 A maintenance schedule will be included in the management system. Damage and repair that is sufficient to prevent ongoing treatment should be notified.
5 Repairs should be initiated within a time frame agreed with the agency.
Contingency planning on site – allowing for storage of chipped clean wood or chipped oversize to correct pore and structure issues of feedstock.
<u>Process Monitoring Controls</u>
6 A suitable monitoring system, both manual and instrumental, is essential to ensure effective operation and to minimise operational difficulties, such as odour and bioaerosols
The key factors to be monitored during the process itself include: • **Temperature and temperature distribution. Thermocouple probes are recommended with remote transmission and data loggers.** • **If open processing forms part of second barrier then ABPR regulation will apply.** • **Moisture assessment and control procedures. Quality assurance with on site drying to validate site based methods e.g. squeeze test.** • **Oxygen monitoring** • **Carbon dioxide monitoring** • **Where oxygen monitoring is not undertaken a systems of corrective action in relation to interpretation of other data is required.** • **Visual and sensory appearance of material – e.g. formation of actinomycetes, fly infestation, odours etc.**
Monitoring of these parameters requires sampling of substrate within the windrow and material at key points in the process.
*** Data should be recorded and records shod be maintained. For specific recommended ranges please refer to section 2.**

5.1.12 Open processes with aeration

Windrow composting can be undertaken using active aeration by forced or negative aeration. This reduces turning activity and potentially reduces residence time. This type of active aeration can be either negative (sucking) or positive (blowing) air usually from the base of the pile.

The pile is constructed in a similar manner to a windrow, but is sometimes also formed as an extended pile Fig 5, where the cross section of the heap is not triangular but is formed in a rectangular bunker configuration.

For each system the waste is constructed and built upon either a series of perforated pipes or concrete with an air supply system cast in situ. These are connected to a fan which provides either negative or positive aeration. Preparation of the base is essential. The pipes should be laid on and covered with, either grade A wood chip or larger woody oversize material. This aids air dispersion through the waste and prevents the pipes becoming blocked. The pipe work will require a schedule of maintenance and cleaning to remain effective. The piles can be covered or enclosed with individual covering structures.

Once the pile is formed, turning or agitation should, with good operational management, not be required provided that the air supply is sufficient and uniformly distributed. Remote thermocouple probes and oxygen monitoring are required to monitor the conditions in the pile. Moisture monitoring is also necessary as the pile may become dry resulting in particulate emission. Settling, drying or dense material could result in preferential pathways develop and requires remedial action. The correct preparation of air delivery system, feedstock preparation structure and monitoring is essential for this system to work adequately together with good housekeeping to maintain the systems.

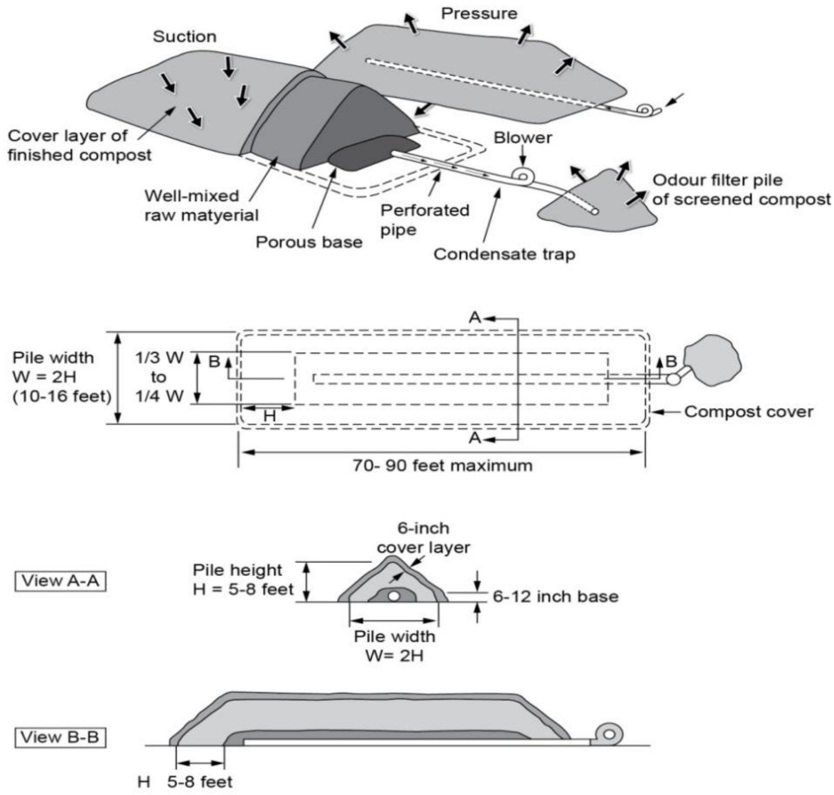
The reduction in turning or restructuring may reduce the risk of emissions of bioaerosols and odours in a negative aeration configuration as air from the pile can be connected to a biofilter to actively manage bioaerosols and emissions. The active composting period could theoretically be reduced if the aeration were managed effectively.

It should be noted that positive aeration systems in open systems may give rise to increased bioaerosol and emissions. Consideration will need to be made for site location and the proximity of sensitive receptors.

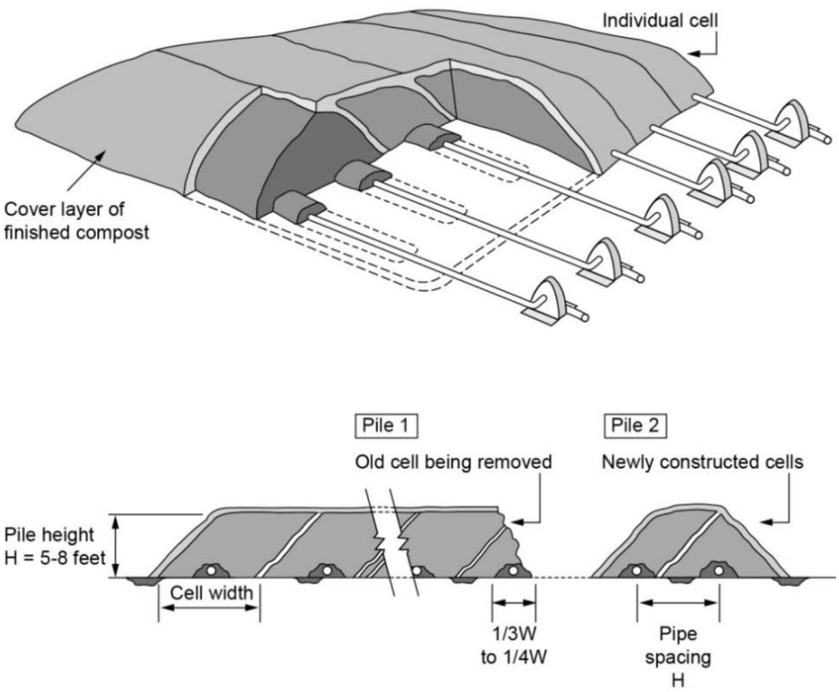
This has evolved to the point where enclosed sealed piles can be compliant with the Animal By-Products regulation. However, this method is not commonly used and operators would need to have the system validated by AHVLA who are the competent authority. Operators are strongly encouraged to engage in early consultation with AHVLA. Contact details for local offices can be found on the AHVLA website (see links in Appendix 12.4).

Active aerated piles can give a greater degree of control over the composting process if the system is designed and maintained properly. For open piles a suction (negative aeration) system facilitates the control of emissions to air by collecting emissions to a point source which can then be treated, for example, using a biofilter. Negative aeration may reduce the level of bioaerosol emissions and decrease the risk of odour in a well constructed and maintained system.

The exhaust air will need to be treated by a designed air abetment system and/or biofilter. Further information on biofilters, including their composition, function and maintenance requirements has been provided in Section 7.5. Aerated static pile dimensions are shown in the figure below.



Aerated static pile layout and dimensions.



Extended aerated static pile layout and dimensions.

Figure 5: Aerated Static Pile and extended Aerated Static Pile

5.1.13 Continuous aerated block composting

Continuous aerated block composting is similar to an aerated static pile in so far as it is constructed on a bed of aeration pipes or a bespoke impermeable concrete pad with cast in situ air ducts. The pile is of a rectangular configuration with a flat top; the difference is that a continuous aerated block is turned, which effectively moves the block of material across the pad. Continuous aerated block without the inclusion of a forced aeration system is known as a Deep Clamp. The effectiveness of Deep Clamp systems suggests that if material is not mixed and prepared well to give adequate structure there is a risk of low rate composting and anaerobic pockets.

With both of these systems it would be expected that air extracted from the negative aeration system would be treated by a biofilter or air scrubbing system.

5.1.14 Indicative BAT requirements for open static aerated treatment

Indicative BAT requirements for open static aerated treatment
1 The area where windrow treatment is to take place should be designed with sufficient capacity for waste to be treated within the retention time of the treatment process and any permit restrictions.
2 The air delivery systems are sufficient size to deliver adequate air to the waste.
3 Capacity within the air systems to ensure that airflow can be adjusted in line with waste data and requirement of the waste treatment.
4 Where the air system is in situ there is a maintenance schedule for flushing though and cleaning.
5 Portable pipe work should be cleaned and inspected after each batch is complete.
6 Preferential pathways are addressed by remixing material
7 Air removal systems should take exhaust air to abatement systems which are designed to treat the systems flow of air.
8 Cycled systems that are also duel leachate control should be inspected daily to ensure that leachate is not pooling around base material.
9 All systems should be cleaned after each batch and air delivery checked.
10 Treatment areas should be engineered impermeable surfaces with kerbed areas to allow collection of runoff and leachate
11 Run off and leachate (dirty water) should be collected in an engineered system and collected in a sump or lagoon.
12 A maintain schedule will be included in the management system. Damage and repair that is sufficient to prevent ongoing treatment should be notified.
13 Repairs should be initiated within a time frame agreed with the Environment Agency.
14 Thermocouple probes should be used or manual probes where the monitoring is taken at 1.5 meter intervals.
15 Probes and monitoring equipment must be calibrated in line with the manufacturers recommended frequency.
16 A suitable monitoring system, both manual and instrumental, is essential to ensure effective operation and to minimise operational difficulties, such as odour and bioaerosols. The key factors to be monitored during the process itself include: • **Temperature and temperature distribution. Thermocouple probes are recommended with remote transmission.**

- **If open processing forms part of second barrier for Cat 3 animal by products, then ABPR regulation will apply.**
- **Moisture assessment and control**
- **Oxygen monitoring**
- **Where oxygen monitoring is not undertaken a system of corrective action in relation to interpretation of other data is required.**
- **Visual appearance of material – formation of actinomycetes, fly infestation**

Monitoring of these parameters requires sampling of substrate within the windrow and material at key points in the process.

HAZOP or HACCP operational management systems should document critical points and measures /management for both equipment and process

5.2 Composting in Closed Systems In-Vessel Composting

In-vessel Composting (IVC) is a term that is widely used to define a compost system within a contained and enclosed vessel. These composting systems, range from enclosed halls to covered bunkers or tunnels and containers, which may be vertical or horizontal.

Wastes which can be treated include green wastes, animal manures, catering and food waste, and animal wastes that are covered by the Animal By-Products Regulations. MBT /MHT organics are usually treated by this technique.

Many of these systems attempt to achieve a higher degree of process control. They may combine the techniques of enclosed windrowing and aerated piles. They attempt to utilise the most positive attributes of each method. In-vessel systems can create even and optimum conditions of temperature and oxygen for the micro-organisms, giving improved control and accelerating decomposition. Enclosed composting is a requirement under legislation for composting waste containing animal by-products.

In-vessel composting systems can be grouped into two categories:

- open piles systems in hall; and
- actual in vessel closed systems or closed bunkers.

The first is typically a set of container/drums/tunnels/agitated bays which are open at the top but which are situated in an enclosed building with a controlled aeration system. The latter are discrete vessels which are completely enclosed. These can be large purpose built operations with concrete bunkers and computer controlled air flows. They can be modular units that can be used for smaller applications e.g. in schools, or even polythene bags or other sealable containers with forced aeration. Please refer to the diagrams below and also to Section 3– Technical Overview of the Composting Process which contains further information on in-vessel systems.

A covered waste reception area is required for compliance with the ABPR regulations. The requirement to enclose the process goes some way to control odour compounds in the feedstock and emission containment conditions as set out in the site's permit. Further stages of these processes can be undertaken in the open, however, an impermeable surface and a sealed drainage system is required and the material needs to be actively and often aggressively managed to prevent emissions. These secondary phases are considered within the Environment Agency's position statement regarding risk to sensitive receptors.

Operators should note that compliance with the ABPR regulations does not necessarily result in a stabilised product. Waste which has been composted in accordance with the ABPR regulations has been sanitised to remove pathogens. This sanitised waste can become active again and become a source of odour emissions. Waste will still require further treatment to achieve the required levels of stabilisation as set out within the Quality Protocol (EA/WRAP 2012).

5.2.1 Tunnels

Tunnels are normally capable of taking more material than a containerised composting system. Air is fed into the system and some systems use mechanical agitation. Bagged tunnel systems have also been available. In these systems the material is loaded into a high tensile polythene skin, using specialist machinery, and an aeration tube is fed in at the time of loading. Control of the system should be undertaken through monitoring of oxygen and temperature levels within the compost.

As with the container type systems the entirety of the material needs to reach the target temperatures in order to meet the Animal By-Products Regulations (Enforcement) (England) Regulations 2011. Some bagged systems have been shown to achieve this through use of an insulating quilt.

5.2.2 Enclosed Halls

Enclosed halls hold all of the material being processed at once. Materials handling equipment, such as large buckets or even specialist machines are used to move the material through the building as it undergoes composting (Fig 6). Aeration systems are usually required to ensure that the process remains aerobic. One of the key problems with this type of system is that unless the system is designed and managed appropriately there will be material of a variety of different ages within the hall. This could lead to difficulties in complying with the Animal By-Products Regulations. The building should be fitted with air handling systems (see Emissions and Abatement, Section 7) and extra care needs to be taken in managing of odour and odorous feedstock.

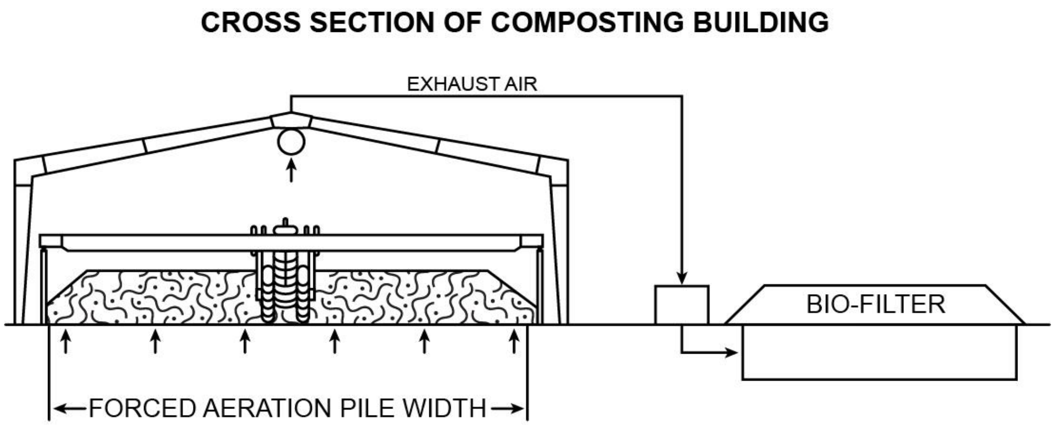


Figure 6: Enclosed Hall

5.2.3 Agitated Bays

Agitated bays are similar to tunnels (Fig7). Containing walls are constructed either side of the bay thus allowing a turner to straddle the bay and move the material along. Several bays can be constructed next to each other and the turning machine moved between them. Due to the containing walls the floor area can be used more efficiently than with a windrow system. Because they are contained at the sides they cannot benefit from the natural ventilation as in open windrows and therefore require artificial aeration. There is the possibility of by-pass within this type of system due to the material being thrown by an overhead compost turner. This would need to be suitably addressed, by design and/or management of the operations, in order to meet the ABP regulations.

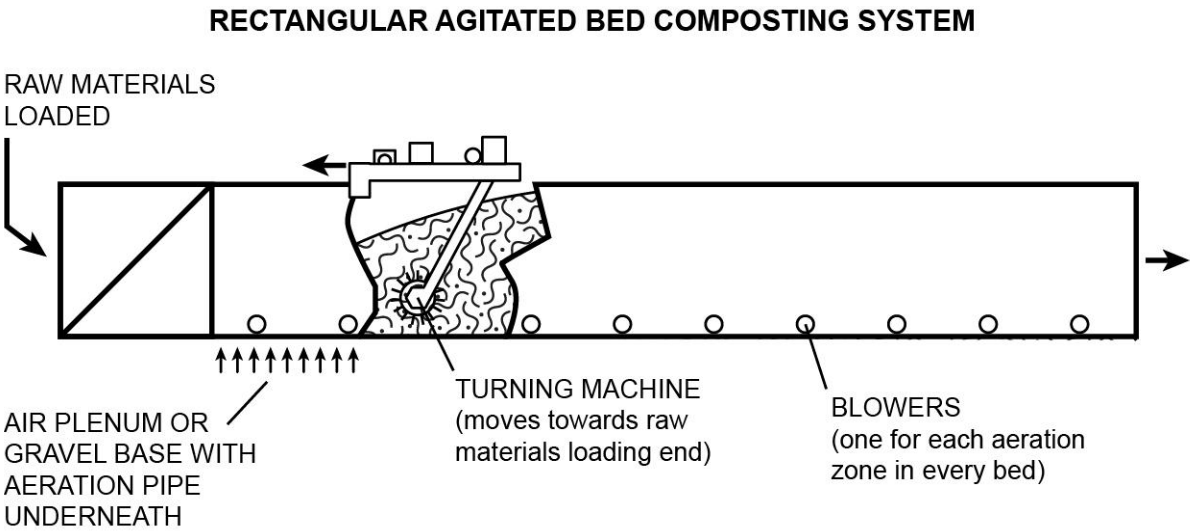


Figure 7: Agitated Bay

5.2.4 Rotating Drums

Rotating drums are large, horizontally mounted drums that rotate as the material is treated (Fig 8). These systems do offer very short processing times and if taking catering waste will need to comply with the Animal By-Products Regulations. Because the process is continuous there is a risk of by-pass without treatment. Therefore the risk and management of critical control points will need to be closely managed. As a result of short cycle times the output material may require further stabilization or maturation in the open.

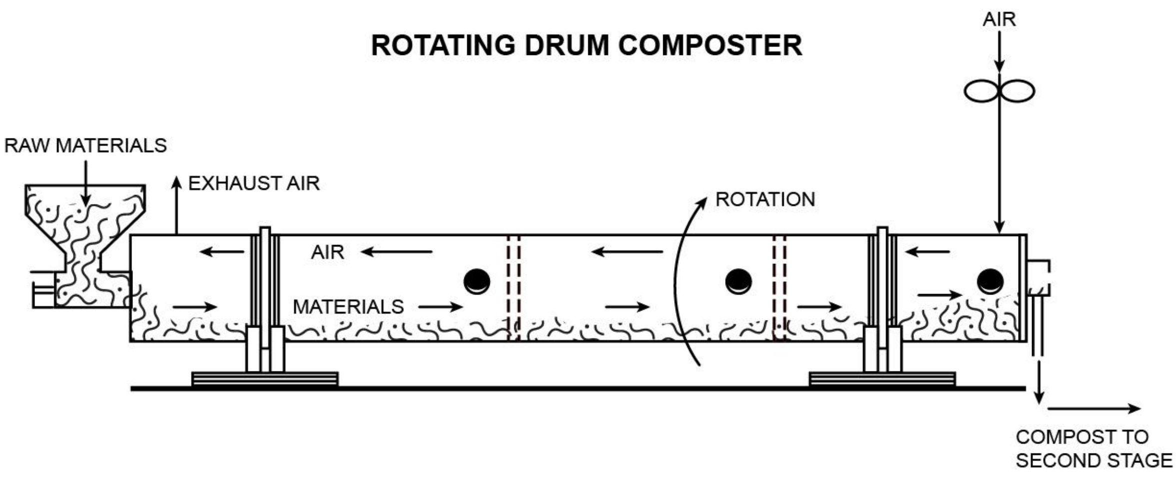


Figure 8: Rotating Drum

5.2.5 Containers

Containers are generally batch type reactors of low volumetric capacity, where air is often forced in through a perforated floor. One of the main advantages of using containers is the relative ease with which the system can be expanded by adding further units. A containerised system is considered superior to an open windrow system due to its uniform aeration and even temperature profiles, combined with more effective emission, moisture and odour controls. Faster composting speeds are also achievable. However, these systems are more engineered and need thorough housekeeping and maintenance to function effectively. They may also require management of emissions.

In order to achieve effective sanitisation of ABPR wastes, both the system and process will need to be approved by AHVLA.

5.2.6 Silos/Towers

Silos or towers are vertical units that normally operate on a continuous or semi continuous basis (Fig 9). Feedstock's are loaded at the top of the vessel and finished compost removed at the bottom. The loading and unloading of vessels can use some quite complex and heavy machinery. Because of the small footprint and height this type of system can achieve large throughputs i.e. a large volume of material can be effectively sanitised with limited land use. However, there is likely to be an additional area required for maturation or complete stabilisation of the compost post in-vessel treatment.

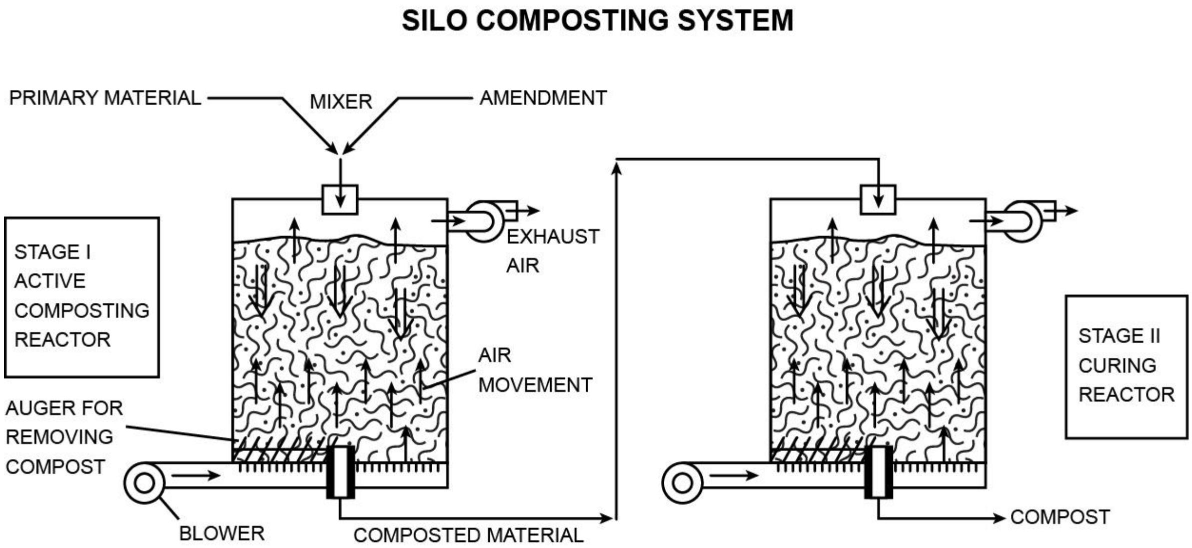


Figure 9: Silo Tower

5.2.7 **Indicative BAT requirements for IVC - general principles**

Indicative BAT requirements for IVC - general principles
<u>Vessel design</u> **1 The vessel or enclosed treatment space should be designed with sufficient capacity for waste to be treated within the retention time of the treatment process until waste is sanitised.** **2 The process should be fully enclosed with an air abatement system.** **3 Treatment areas should have engineered impermeable surfaces with kerbed areas to allow collection of runoff and leachate** **4 Run off and leachate (dirty water) should be collected in an engineered system and collected in a sump or lagoon and kept separate run off from other areas.** **5 A maintenance schedule will be included in the management system. Damage and repair that is sufficient to prevent ongoing treatment should be notified.** **6 Repairs should be initiated within a time frame agreed with the Environment Agency.**

Management and Pre Treatment of Wastes

7 The pre-treatment of wastes to remove non-biodegradable material and contaminants from feedstock and also to provide optimal substrate characteristics to enable an effective and efficient digestion process.

8 The objectives of pre-treating feedstock will typically include;

- **Removing packaging material from food waste (depackaging) where the packaging is not certified biodegradable or compostable**
- **Removing other non-biodegradable materials e.g. grit & metal, which are not affected by the process.**
- **Providing a uniform small particle size feedstock for efficient composting**
- **Protecting the downstream plant components that may cause physical damage**
- **Critical spare parts should be carried where possible**

9 Where ABP and non ABP material are processed the facility should allow for both materials to be segregated preventing cross contamination. Leachate collection should be separated.

10 Where ABP material is processed, wheel wash facilities should be provided for the disinfection of delivery vehicles on exit from the reception hall. All other cleansing of ABP delivery vehicles should be carried out in an enclosed area.

11 Where ABP material is processed, pre-treatment must meet minimum particle size requirements as specified by the ABP regulations

- **A discrete quarantine area should be provided for the segregation of unacceptable wastes. Removing materials contrary material from site within 5 days**

Storage of Chemicals

12 Should comply with the COSHH requirements of the specific chemical

Process Monitoring Controls

13 A suitable monitoring system, both manual and instrumental, is essential to ensure stable process operation and to minimise operational difficulties, such as anaerobic conditions which may lead to odour and aesthetic problems.

- **The key factors to be monitored during the process itself include but are not limited to :**
- **Temperature and temperature distribution**
- **Moisture**
- **Oxygen**
- **CO2 / O2**
- **pH**
- **Biofilter and air management and abetment systems should be monitored as section 7 .**

14 Monitoring of these parameters requires sampling of feedstocks and waste being processed, at key points in the process. The system design should allow for this. Regular laboratory testing will be required to analyse samples where liquids are accepted and the operator should consider provision for on-site laboratory facilities at large scale facilities

Worker exposure

15 Air extraction should designed and maintained to move and handle the volume of air to

provide a clear working environment

16 Workers in enclosed and confined spaces should wear personal alarms to monitor for H_2S and CO. Periodic personal assessment of bioaerosol exposure should be undertaken in line with sites occupational exposure process and H and S guidelines.

5.2.8 Thermophilic Aerobic Digester (TAD)

Thermophilic Aerobic Digestion (TAD) has been used historically for the treatment of sewage sludge but is beginning to be used to treat waste food. Its use to treat food waste is relatively limited at present, but there are a few permitted sites in England and Wales. These can be either continuous flow or batch fed systems.

Bacterial digestion is used in this process whereby bacteria consume and degrade the organic matter in the presence of oxygen. The process releases water and carbon dioxide, and producing a final waste product (digestate).

Prior to digestion the waste material is macerated and mixed with water or other liquid waste to form a slurry/sludge. The slurry is transferred to reactor vessels fitted with oxygen distributors and stirring devices. The thermophilic bacteria generate heat up to 75^{o}C, which is compliant with the ABPR. A retention time of 20 days is considered best practice. Faster or accelerated retention times are currently not well established in the UK.

The digestate is usually dewatered or dried to produce a bio-fertiliser. The digestate may also be useful as a feedstock to Anaerobic Digestion (AD) facilities.

5.2.9 Start-up of a TAD unit

There is no standard procedure for start-up of a TAD system and procedures should be specified by the technology supplier and detailed as part of the design and commissioning process. An overview of considerations during the start-up process is provided below.

The commissioning process will require testing of all equipment and pipework prior to loading the digester. Seeding of the digester is conducted to provide active biomass prior to loading the digester with feedstock material.

Approaches to loading a digester on start-up may require a stepped increase in loading based on the rate of conversion of feedstock, starting with the reactor only 50% full for example.

Other procedures may flood the digester as this provides a better examination of the pipe work and is, in effect a wet commissioning of all the mechanical and electrical components. The key elements of a start-up procedure are consistent in both approaches and include;.

- The preparation of a viable biomass from a suitable supply source;
- The acclimatisation of the biomass to the feedstock; and
- The gradual loading of the biomass up to the design conditions under close monitoring.

The biomass (inoculum) used in seeding the digester during start-up should ideally be sourced to match the type of feedstock to be processed at the facility. For example, if the main feedstock to be processed is food waste then digested material from a successfully operating food waste TAD plant should be used.

Gradual loading and commissioning of the digester may be required in order to ensure that optimal conditions for the growth of aerobic micro-organisms are maintained.

Regardless of the procedure, monitoring VFA concentration and pH is important for assessing the performance of digester during start-up. Where gradual loading is used, the empty air space in the digester should be flushed with air in order to prevent the creation of off gas build up.

5.2.10 Indicative BAT requirements for TAD - general principles

Indicative BAT requirements for TAD - general principles
<u>Management and Pre Treatment of Wastes</u>
1. The pre-treatment of wastes to remove non-biodegradable material and contaminants from feedstock and also to provide optimal substrate characteristics to enable an effective and efficient digestion process.
2. The objectives of pre-treating feedstock will typically include; • **Removing packaging material from food waste (de-packaging)** • **Removing other non-biodegradable materials e.g. non-biodegradable materials glass, metal etc, which are not affected by digestion and take up necessary space** • **Providing a uniform small particle size feedstock for efficient digestion** • **Protecting the downstream plant from components that may cause physical damage** • **Removing materials which may decrease the quality of the digestate**
3 Where ABP and non ABP material are processed the facility should allow for both materials to be segregated preventing cross contamination.
4 Where ABP material is processed, wheel wash facilities should be provided for the disinfection of delivery vehicles on exit from the reception hall. All other cleansing of ABP delivery vehicles should be carried out in an enclosed area with a dedicated interceptor and dirty water collection.
5 A discrete quarantine area should be provided for the segregation of unacceptable wastes.
<u>Vessels and pipe work where applicable</u>
6 Vessels used for treatment should be equipped appropriately e.g. high-level, temperature and gas pressure monitors.
7 These should be automatic and continuous and linked to a clear display in the control room or laboratory together with an audible alarm.
8 Depending on the operational model, location, and manning levels, process monitoring may be interlocked so that, for example, digester feeding stops when an alarm condition is evident. The detailed requirements for process monitoring, alarms and interlocking should be informed by risk assessment.
9 Vessels should be fitted with an appropriate mixing/stirring mechanism for the type of vessel and waste to be processed to: • **ensure efficient mixing** • **ensure complete digestion; to prevent short circuiting (whereby feedstock is diverted out of the digester before being fully treated); and** • **to ensure uniform heat transfer and to prevent sedimentation of silt and stratification in the reactor** • **adequate oxygenation of material**
10 Operators should demonstrate that all process equipment including vessels, ancillary pipe work, valves and other mechanical and electrical items and controls are made of materials suitable for each unit operation and to achieve the stated availability and design life of the plant as stated in risk assessment method such as HAZOP.

11 Workers in enclosed and confined spaces should wear personal alarms to monitor for H_2S and CO. Periodic personal assessment of bioaerosol exposure should be undertaken.

Process Monitoring Controls

12 A suitable monitoring system, both manual and instrumental, is essential to ensure stable reactor operation and to minimise operational difficulties, such as foaming, which may lead to odour and aesthetic problems.

- **The key factors to be monitored during the digestion process itself include:**
- **Temperature and oxygen distribution**

13 Monitoring of these parameters requires sampling of digester feed, substrate within the digester, digestate and biogas at key points in the process. The system design should allow for this. Regular laboratory testing will be required to analyse samples and the operator should consider provision for on-site laboratory facilities at large scale facilities.

HAZOP or HACCP procedures should be documented and adhered to as part of the operational management system for both equipment and process control. Records should be maintained detailing repair and maintenance.

6 Processed Material – Use and Storage of Compost/TAD digestate

6.1 Introduction

Ready access to chemical fertilisers over the last 50 years has increased agricultural production yields. However, it is recognised that the manufacture and use of inorganic fertilisers give rise to particular issues, arising both from fossil fuel use and from nitrous oxide emissions. The use of compost can help to displace chemical fertilisers by providing a significant organic fertiliser.

Compost is the resulting material from the treatment of biodegradable waste that has undergone full biological decomposition and stabilisation. The composting process should provide a stable sanitised material that can be used beneficially on land, including use as a fertiliser or soil improver, the horticulture and growing media industry.

6.2 Post Treatment

The stability of compost depends on the type of feedstock, the pre-treatment, managed composting process, residence time and end market. Shortening residence time will potentially produce unstable material that will require additional care in storage prior to use.

As a minimum requirement, compost should be tested in order to confirm that the process is achieving the required level of treatment. This is usually indicated by the stability of the treated material. Compost sampling and testing may be required to demonstrate the compost is fully stabilised. Currently PAS100 provides details of the standard required. Storage of compost that has met a certification standard is covered in the CQP.

Compost that is produced from wastes and that does not meet the QP and PAS100 protocols will still be a waste and its use will therefore be subject to further regulation by the Agency. The use on land of any such waste compost will require an Environmental Permit and Deployment authorisations. Such wastes should consist of a stable sanitised material that can be applied to land for the benefit of agriculture or to improve the soil structure or nutrients in land. Operators should refer to additional guidance for land spreading Appendix 12.4.

Compost screened using rotating screens and may require wind sifting depending on feedstock contamination.

A variety of fibre separator systems that are used for TAD digestate separation, including;

- rotary screens;
- flat belt separators;
- roller presses;
- vibrating screens;
- centrifuges; and
- screw or ram presses.

6.2.1 Storage of Compost and TAD fibre /digestate

Storage of compost represents a potential source of emissions both off gases, bioaerosols and leachate run-off. On-site storage must be designed to prevent emissions and minimise risk of pollution. Operators must ensure that sufficient provision has been made for storage prior to distribution. Storage provision should also take into account situations where the land-bank may be unavailable for prolonged periods, for example, where the land is waterlogged or frozen. Losses of nutrients from storing and handling of compost is possible.

Where compost is stored pending application on agricultural land in a Nitrate Vulnerable Zone, sufficient safe storage capacity must be available to ensure pollution prevention and contingency in closed spreading periods.

In accordance with NVZ regulations storage requires at least:

- 6 months (1 October to 1 April inclusive) storage capacity for pig slurry and poultry manure; and
- 5 months (1 October to 1 March inclusive) storage capacity for other livestock slurry e.g. cattle slurry.

6.2.2 Indicative BAT requirements for compost storage

Indicative BAT requirements for screened and finished compost storage
Screenings activity is liable to give risk to bioaerosols, odour noise and litter **Screening of finished and stabilised compost must:** **1. Take place within the permitted area. Further treatment off site to meet a product specification or further refinement is not permitted outside the permitted area. Material stored to meet additional stability e.g. horticultural specification should be stored on the permitted area.** **2 Screened material must be stored upon an impermeable surface supplied with a sealed drainage system where risk to the environment are identified. .** **3 Operators must ensure that sufficient provision has been made for storage prior to distribution especially in closed spreading periods. Storage provision should take into account situations where the land-bank may be unavailable for prolonged periods, for example, where the land is waterlogged or frozen.** **4 Compost must be stored in a manner that will minimise odour and bioaerosols and not give rise to pollution.**

TAD digestate must be stored within covered tanks or covered lagoons and should be of a design and capacity fit for purpose. Lagoons should have a free board of minimum 750 mm with a high flow alarm. They should be aerated and within the permitted area.

Where digestate is dewatered, the fibre must be covered either in a Dutch barn or sheeted and stored on an impermeable surface with a sealed drainage system or further stabilised by composting.

6.2.3 Indicative BAT requirements for storage TAD facilities

Indicative BAT requirements for digestate treatment and storage
Separation of TAD digestate **1.Separation of solid/fibre proportion of digestate must:** • **Take place within an enclosed building which is kept under negative air pressure.** • **The building should have fast acting roller shutter doors provided for access and egress.** • **Exhaust air from processing/separating and storage areas will require abatement prior to discharge to atmosphere.** • **The separation/processing digestate should be carried out on an impermeable surface with a sealed drainage system.** • **Where separated fractions do not meet the PAS or QP standard, these fractions must continue to be treated as wastes.** **Storage of digestate** **2 Digestate must be stored within covered tanks or covered lagoons and should be of a design and capacity fit for purpose with leak detectors and aeration of stored materail. Lagoons should have a free board of minimum 750 mm.** **3 All such storage areas (including those for the storage of solid fractions) should be provided with appropriate emissions control and abatement systems.** **4 Separated digested materials must be stored upon an impermeable surface serviced by a sealed drainage system.** **5 Operators must ensure that sufficient provision has been made for digestate storage prior to distribution especially in closed spreading periods.** **6 Digestate must be stored in a manner that will minimise odour and not give risk to pollution. Storage provision should take into account situations where the land-bank may be unavailable for prolonged periods, for example, where the land is waterlogged or frozen.** **7 Where digestate is stored pending application on agricultural land in a Nitrate Vulnerable Zone, sufficient storage capacity must be available to span the winter closed spreading periods.** **8 On-farm digestate storage structures must be compliant with the requirements of the SSAFO regulations.**

6.2.4 Indicative BAT requirements for lagoons and finished material storage

Indicative BAT requirements for lagoons and finished material storage
The Environment Agency is currently working with industry to agree standards of construction for storage tanks, and lagoons. We will update this guidance when that is work is completed. **Further guidance on How to comply with your land spreading permit is available (see 12.4)**

7 Emissions control and abatement

7.1 Overview

The composting and aerobic treatment degradation process can be described as the conversion of unstable carbon compounds to a final stable material. Carbon based material does not facilitate the production of complex intermediate by-products. This conversion is accomplished by microbes that break down the original carbon structures to obtain the energy released from that break down. At this point, CO2, water, and energy are released. As part of the process of biodegradation and conversion range of intermediate compounds are generated. Many of these are the Volatile Organic Compound (VOC's), including organic acids, that make up the majority of odorous compounds in composting. Ammonia and H2S are encountered much less often than alcohols, ketones, aldehydes, organic acids, and mercaptans other trace gasses.

If the material is within a vessel then it is possible to gather and manage the exhaust air to reduce concentrations released to air to acceptable levels. The most common abatement technology is a biofilter or wet scrubber or a combination of both. It is of key importance that the configuration, commissioning and maintenance (planned and emergency down time) of these abatement systems are considered carefully to minimise pollution and release of fugitive emissions.

Different feedstocks are liable to produce 'challenging' off gases and the design of the abatement technology must take this in to consideration to prevent pollution. Guidance on best practice of design and maintenance of abatement systems for biowaste operations will be produced in 2014, but a summary of the basic requirements are provided in this chapter.

Most biofilters or configurations of combined systems will not be 100% efficient at removing all gases, but will aim to reduce the release at point source to an acceptable level. Biofilters may also become a source of odour and bioaerosols depending on the type of packing media, maintenance and age of the substrate or packing materials.

Open biofilters are considered as a point source emissions, as are stacks, and monitoring will need to reflect the efficiency of removal/ reduction of off gases to demonstrate that release at a point source is acceptable. Failure to do so will result in a fugitive emission that will not be considered BAT or appropriate measures.

It is key that the critical control parameters that are likely to result in anaerobic conditions are managed as described in Section3, 4 and 5.

7.1.1 Open processes

If the composting is occurring outside, then the management of the process, through feedstock selection and processing, is an important factor in reducing the concentrations of bioaerosols and odorous gasses. The other parameters, as detailed in Section 3, 4 and 5, are critical to mitigate and minimise pollution.

Negative aeration or aerated static piles are currently considered to be best practice to control bioaerosols where operations are located close to sensitive receptors. They will require a well-designed, commissioned and maintained abatement system.

In both in-vessel and open processing the treatment of bespoke /more novel waste must take into account the control of emissions during the biodegradation of the waste. For most industrial waste streams enclosure and control by abatement systems is the most appropriate technology to remove harmful or odours of gases that may occur during biological treatment.

7.1.2 Fugitive emissions to air

Operators will minimise risk of fugitive emissions provided they are using appropriate measures. Fugitive emissions include bioaerosols, particulates and odour which may occur from all stages of the process. Suitable operational procedures should be developed and followed to minimise fugitive emissions during these processes as detailed in Section 3, 4 and 5.

It is critical to fully understand the mechanisms and events which cause fugitive emissions to arise. Where the residual odour pollution is, or is likely to be, unacceptable the Regulator will work closely with operators to help them find solutions that will avoid or minimise this eventuality.

The main control of fugitive emissions is prevention by developing a systematic approach considering all sources and measures that could be reasonably taken to reduce emissions and therefore pollution. Regular scheduled checks and maintenance, including monitoring, leak detection tests and other plant monitoring should be scheduled and documented.

Examples of common sources of fugitive emissions are:

- Managing waste inventories
- Waste reception areas
- conveyor systems
- storage areas (for example, bays, stockpiles, lagoons, etc.)
- open vessels (for example, digestate storage tanks)
- sampling activities
- the loading and unloading of containers
- transferring/bulking up of material from one vessel to another
- overly high temperatures for long periods of time
- dry conditions allowed to persist in treatment
- overly wet and dense materials with reduce pore space
- oversized windrows
- turning and agitation
- screening
- operations exceeding carrying capacity of the site
- pipework and ductwork systems (for example, pumps, valves, flanges, catchpots, drains, inspection hatches, etc.)
- lagoons
- poor building containment and extraction
- potential for by-pass of abatement equipment (to air or water)
- spillages
- accidental loss of containment from failed plant and equipment
- tanker and vessels manhole openings and other access points
- displaced vapour from receiving tanks
- cleaning or replacing of filters
- condensate storage and handling
- drum storage

- tank cleaning
- tanker washing
- abatement systems

This is not an exhaustive list. However, as part of the application the operator should identify and, where possible quantify, significant fugitive emissions to air from all the specific relevant sources, estimating the proportion of total emissions that are attributable to fugitive releases for each substance. Where there are opportunities for reductions, the permit may require the updated inventory of fugitive emissions to be submitted.

7.2 Odour

Odour is the perception of certain chemicals within the olfactory area of the sinuses. In order to be perceived in this way a chemical must meet all of the following criteria:

- There must be a source of the chemical as described in section 7.1 above (source)
- The chemical must be released into the air and transported in air to the receptor; (Source Pathway)
- The chemical must dissolve in the olfactory mucus (mostly water) (Pathway/ receptor) and
- There must be a receptor nerve cell available that can detect the chemical.(receptor)

Biodegradable waste materials generate odour as they biodegrade. Three main sources of odorous compounds from composting activities are identified in specific odour guidance (The Composting Association, 2007):

- Most feedstock materials naturally contain odorous compounds such as limonene from citrus fruits or pinene from woody materials. Individually these chemicals are not considered particularly offensive however in mixture particularly with the smell of putrefaction the results can be a "rotting food" smell.
- Odours are produced during the natural breakdown process occurring in aerobic composting. This can begin during storage. In particular large molecules (fats, proteins) break down into smaller molecules and some of these breakdown products are intrinsically highly odorous for example amines and fatty acids which are the result of complex by products of degradation.
- Odours are produced when anaerobic conditions prevail in the composting material. When oxygen becomes metabolised and depleted, some micro organisms adapt their metabolism (facultative anaerobes) whilst other, truly anaerobic micro-organisms will become active. The result of this process is that the micro-organisms metabolise compounds other than oxygen, for example sulphates, which regularly result in recognisable offensive smells such as hydrogen sulphide.

7.2.1 Odour management- odour management plans

Prevention or minimisation of odour emissions through an active odour management plan (OMP) is a requirement for permitted sites in the UK. As well as being a regulatory requirement there are several additional benefits to the operator in producing an OMP, including;

- identification and reduction in impact from identified risks;
- establishment a trust based relationship with stakeholders;
- minimisation of odour management costs; and
- optimisation of odour abatement equipment.

An OMP requires the operator to assess the potential level of odour pollution at the site or facility and to implement appropriate monitoring and control measures in accordance with the Environment Agency's Horizontal Guidance H1 and H4 (see appendix links 12.4).

Table 12 below lists some of the potential sources of odour arising from a compost facility and some suggested mitigation measures that are considered appropriate to minimise odour issues arising on site.

Potential Source of Odour	Mitigation Method
Malodorous feedstock receipt at facility	Suggested BAT would be to reject excessively malodorous loads at the weighbridge unless there are robust systems in place to control and contain odours. Booking in waste to allow for prompt processing as waste arrives, and planning contingency or down time and shredder time. Blending of feedstocks with materials that adsorb odour such as finished compost product. Covering feedstock's with a woodchip to act as a temporary 'biofilter ' Ensuring collection of loose waste, either between windrows or in open drainage and collection systems, where they may become anaerobic. Robust management procedures - rapid processing or enclosure e.g. fast acting roller shutter doors air locks maintained under negative pressure. Air extraction systems in enclosed spaces with a minimum of 3-5 air changes per hour.
Stockpiled unprocessed feedstock becoming odorous	Minimising storage of feedstocks. BAT - all putrescible waste are processed within 48 hours other feedstock's should be processed within 5 days and preventing anaerobic conditions my management and monitoring First in first out (FIFO) management is always used Enclosed stockpiling and management of feedstock with air management system for all catering waste. Aeration of stockpiles during prolonged storage in both open and enclosed systems.
Shredding and processing /turning of composting materials	Enclosed area for shredding with air handling where sites are located within 250m of sensitive receptors and required when ABPR waste is treated. Temperature control of waste. Moisture monitoring correction and control in processing Oxygen measurements Minimising shredding and turning of compost materials during windy conditions or when wind is blowing towards sensitive receptors. Turning as indicated by monitoring conditions in process.

	Turning technologies considering feedstock.
Processing of biowastes	Controlled environment systems to maintain aeration of materials, prevent and contain and treat emissions Porosity and structure in loading vessels or building open windrows Monitoring key control parameters Installation of biofilters (or other effective abatement systems) for enclosed/ in-vessel system or open static piles Minimising agitation and turning of open windrow composts when prevailing wind could carry odour towards sensitive receptors. BAT: Installing static pile aeration Appropriate windrow height as Section 5.1.9
Emissions from odour treatment systems	Appropriate design, commissioning monitoring, management and maintenance of systems to contain and abate odour and bioaerosols
Effluent handling and storage system	Robust foul water and leachate management system to minimise run off from organics/composting materials Maintenance of handling and storage system to limit standing effluent. Clean water management, and resource planning - separate clean from dirty water and foul run off Aeration of leachate lagoons, high level alarms and freeboard maintained. Venting underground systems
Facility maintenance/equipment cleaning.	Risk assess prior to undertaking maintenance Avoid periods when odour arising from maintenance could impact on sensitive receptors due to windy conditions. Contingency for downtime and breakdowns so that waste is not stock piled Deep cleaning of vessels in between loading to ensure air delivery/leachate systems are clear Design biofilters on a modular basis so that some parts of abatement can be kept in operation during staged refurbishment

Table 9: Prevention through active odour management procedures

Whilst prevention of malodours through good operational management will always be the priority for composting facilities, treatment of odour emissions will be a requirement for most enclosed facilities. The exact type of odour control systems will depend on the scale and type of odours that are anticipated. They can include biofilters, chemical scrubbers, ozone treatment, neutralising agents and localised barriers e.g. atomiser.

The current odour condition used in the environmental permits is shown below and usually consists of two elements:

- the odour boundary condition, which specifies the outcome which the operator must achieve (i.e. no pollution beyond the site boundary); and
- a condition requiring compliance with an approved Odour Management Plan (OMP) (where activities are considered likely to give rise to odour).

7.2.2 Indicative BAT for odour

Indicative BAT requirements for odour control
Issues as per Table 11 should be fully considered and risk inventory and management strategy developed. **1 Site design and management of waste should demonstrate consideration of Section 2 above.** **2 The main constituents and inventory of the emissions should be identified. This will allow the appropriate measures and abatement technology to be selected to remove or reduce emissions.** **3 Waste acceptance and feedstock should be characterised and fully understood to allow for proactive management as section 3 and 4 above. Waste is processed and monitored aggressively to address temperature, moisture and C:N ratio as a minimum to optimise the process. Material should be processed promptly within 48 hours if practicable or as a maximum within 5 days (FIFO) or stored to prevent anaerobic degradation or decays amending the composting mixture** **4 Best practice should be employed as per sections 2- 5 above**, **5 Where odour-generating activities take place in the open, (or potentially odorous materials are stored outside), a high level of management control and use of best practice to prevent odours will be expected as above. Avoidance of processing activity that are high risk of producing odour during unfavourable meteorological conditions such as turning, screening and shredding.** **6 The following general techniques should be employed :** • **Covering of skips to and from site and in storage.** • **Avoidance of unmonitored or unmanaged outdoor or uncovered stockpiles (where possible)** • **Where dust creation is unavoidable, use of sprays, binders, stockpile management techniques, windbreaks etc are employed based on risk assessment** • **Wheel and road cleaning (avoiding transfer of pollution to water and wind blown particulate)** • **Closed conveyors, pneumatic or screw conveying (noting the higher energy needs). Filters on the conveyors to clean the transport air prior to release** • **Regular housekeeping** **7 Where odour and emissions can be contained, for example within buildings, the operator should maintain the containment and manage the operations to prevent its release at all times.**

8 Releases should be modelled and it is expected that the operator will achieve the highest level of protection that is achievable with BAT from the outset. Where odour releases are expected, these are acknowledged in the permit, (i.e. contained and treated prior to discharge or discharged for atmospheric dispersion) limits are initially agreed based on H1 risk assessment. Where a facility releases odours but has a low environmental impact by virtue of its remoteness from sensitive receptors, it is expected that the operator will work towards achieving the standards described in this note, but the effort and timescales allowed to achieve this might be adjusted according to the perceived risk.

9 Where odour generating activities take place in the open (or potentially odorous materials are stored outside) a high level of management control and use of best practice will be expected as per above sections.

10 Scrubbers and biofilters should be designed, commissioned and monitored to ensure optimum performance, i.e. operating at correct pH, ensuring adequate chemical wash replenishment and replacement and pressure drop monitoring. Scrubbers should be alarmed.

11 Records should be kept by the operator of all monitoring undertaken and the monitoring results, measures taken and maintenance repairs.

12 When maintaining or cleaning scrubbers filters, filter pot lids should be replaced as soon as possible. Re-commissioning is usually necessary for new biofilter media and contingency for down time periods needs to be considered at the design stage. The Agency should be informed of any scheduled or emergency works and agree a programme of works. The operator should establish communication with local communities to inform of any disruption that may give rise to odours or nuisance ahead of work progressing.

13 Contaminated waters and leachate from scrubbers and blow down valves/pots have potential for odours and liquids should be stored in covered containers and removed off site promptly. These wastes may be considered hazardous waste.

14 Maintenance schedules should ensure regular cleaning/desludging of drains or tanks to avoid large scale decontamination activities. All odorous materials being transferred directly to sealed containers.

15 Consider venting containers and /or tankers to carbon filters where appropriate and safe to do so.

16 Where operators fail to control emissions, a full reassessment of the site must be made preferably by an independent and suitably qualified person. H1, H4 (OMP) and SSBRA documents are dynamic and need to be reviewed if processes change, tonnage increases or there are frequent and repetitive incidents of pollution or emissions above agreed and permitted limits. These must be reviewed as indicated above or on a 12 monthly basis.

7.3 Bioaerosols

Bioaerosols refer to micro-organisms, including fungi and bacteria suspended in the air. Bioaerosols are generally <10 µm in size and are not typically intercepted by hairs and specialised cells that line the human nose and upper respiratory system.

Exposure to bioaerosols has been associated with human health effects and symptoms usually manifest as inflammation of the respiratory system, coughs and fever. Inhalation of bioaerosols may cause or exacerbate respiratory diseases, for example Farmers Lung. Farmers Lung is a form of extrinsic allergic alveolitis, which is a lung disease that can develop after exposure to certain substances. It is the outcome of an allergic response to a group of microbes, which form mould on vegetable matter. Bioaerosols have been also known to cause gastrointestinal illness, eye irritation and dermatitis.

The Environment Agency "Composting and potential health effects from bioaerosols: guidance for permit applicants" refers to the need to control harmful bioaerosols. This guidance will be taken into account before authorising any new composting facility located where the composting operations would be within 250 metres of sensitive receptors.

If operations are within 250 metres of workplaces or dwellings the developer must carry out a Site Specific Bioaerosol Risk Assessment (SSBRA) in support of their application. Before granting a permit the Environment Agency must be satisfied that the SSBRA shows that the proposed activities would be unlikely to expose the nearest sensitive receptor to elevated concentrations of bioaerosols from the composting activities for prolonged periods.

Standard methods of determining bioaerosol levels are available. However, based on the present scientific understanding of bioaerosols, the way they behave and their health impacts, it is now considered that there are currently no suitable methodologies for carrying out adequate quantitative SSBRAs for new composting facilities. Accordingly, the Environment Agency will need to take a precautionary approach, and not normally permit those facilities where a quantitative SSBRA would have been expected, until such time as a suitable methodology becomes available, unless additional measures for control are put in place by the operator.

Composting at aerobic treatment installations are affected by this approach and would have carried out any "composting operations in the open that are likely to result in the uncontrolled release of high levels of bioaerosols", as defined above. In practice, this would not include situations where the entire composting operation is carried out inside a building, or where composting takes place outside, but using negative aeration and without turning. However, it would include compost maturation in conventional outdoor turned windrows, carried out following other treatment operations such as in-vessel composting, treatment in a dry AD (anaerobic digestion or where AD digestate is stored in the open and treatment in an MBT (mechanical biological treatment) plant.

For further details regarding the exposure of "the nearest sensitive receptor to elevated concentrations of bioaerosols from the composting activities for prolonged periods" please refer to our current composting and bioaerosols guidance (revised November 2013), included as Appendix 12.4.

Guidance on the evaluation of bioaerosol risk assessments for composting facilities is available on the Environment Agency's website (see links in Appendix 12.4). Please note we will be revising this risk assessment guidance in 2014 and operators will need to be aware of additional information.

Where a risk assessment has been agreed, as part of your application, this will form part of your agreed operational management system control of fugitive emissions of bioaerosols. Operations will be assessed against the agreed mitigation measures in the document. Where installations change their process, abatement or increased tonnage a new risk assessment should be undertaken and agreed with the regulator.

7.3.1 Bioaerosol Abatement

The operational control measures stated in sections above will assist in mitigation of all emissions and pollution. This section provides guidance with relevance to bioaerosols;

Operators must consider the inventory of risk for release of bioaerosols. Mitigation measures must be in place if facilities are within 250m of a sensitive human receptor. Operators are also advised that they must consider the exposure of staff and visitors and take measures to avoid or reduce prolonged exposure to bioaerosols. Where workers are required to be in operational areas for long periods of time then they must be fitted with appropriate PPE. Further information can be found at the ORG and HSE web pages.

At compost facilities, the primary abatement measures for bioaerosol release are to reduce the release and remove the pathways between source pathway and receptor;

- reducing point source releases;
- containing and abatement emissions;

7.3.2 Reducing point source releases

The simple monitoring and amendment to moisture in waste can considerably control dust generation and in turn restrict the release of bioaerosols. High temperatures, even in static piles, encourage bioaerosols to rise in thermal columns which can then be carried by the wind. Controlling moisture and temperature is critical.

Damping down haul roads and ensuring the operational areas swept regularly reduces the risk of dry and wind blow particulate.

In open processing systems the option of covering windrows using a fabric or membrane cover may assist in the containment of fugitive and organic emissions from open windrow facilities. Such materials may allow fugitive emissions to be contained within a textile membrane cover that encapsulates the compost windrow. However, the operator would be required to provide evidence of the efficacy of such a system. Such membranes may require specialised handling equipment and protection from damage. Using these systems requires monitoring and alertness to increased temperature and conditions where malodorous areas may develop and material may become too dry.

Site position in relation to prevailing wind conditions can play an important role in control and mitigation of emissions and should be considered at the design stage. Altering or reducing composting turning activity, particularly during strong winds, is recommended particularly if wind direction is towards sensitive receptors. However, reliance on wind direction and cessation of activity can result in other issues such as odour etc. Active interpretation of monitoring can ensure that turning is undertaken only when necessary.

Negative aeration will reduce the need for turning and may reduce the incidence of bioaerosols. Similarly the use of a bagged system can reduce bioaerosols. However, in both of these systems there has to be some initial shredding and preparation of material as well as screening at the end of processing.

The use slow speed shredders and use of baffles over shredding and turning equipment can help reduce bioaerosols created during processing. Front end loaders and telescopic handling can generate intermittently high bioaerosols. The addition of boundary or operationally placed misting atomisers may cause bioaerosols to ‘ground earlier.’

Windrows should be orientated to take into account the direction of the prevailing wind. . The smallest possible area of composting mass should be exposed to the prevailing winds to avoid ‘stripping’ of windrow surface and preferably at the lowest elevation within the overall site layout.

The use of bunds, trees and banking may increase air turbulence at the site boundary. The use of landscaping may improve dispersion.

7.3.3 Containment

Containment of waste/substrate reception and treatment processes presents opportunity for additional mitigation by treating exhaust air in abatement systems. Appropriate and effective extraction systems should be incorporated into the site design. The design should consider the waste types being treated potential species of off gases and emissions (including particulate) and the commission and maintenance of the abatement systems. This is a specialist area and poor design and maintenance will lead to operational problems and non compliance with permit conditions. The costs associated with providing containment will vary significantly depending on the composting process and scale of operation.

There is risk of release of bioaerosols during deliveries and other activities that may require the doors to be opened. Operators should consider the activities and potential releases during these activated to minimise fugitive releases and air locks may need to be considered in sensitive locations.

Most operations rely on biofiltration to reduce or remove both odours and bioaerosols. It should not be assumed that a biofilter would be effective in reduction of both bioaerosols and odours and it is recommended that a two or three combination abatement may be necessary.

Health and safety considerations regarding working in a contained environment also need to be considered, and this is one the reasons why containment is must be accompanied by a designed air extraction and odour abatement and treatment system to treat extracted air.

7.3.4 BAT for prevention and mitigation of bioaerosols;

Indicative BAT requirements reducing bioaerosols
A full and complete inventory of potential bioaerosols point source emissions must be made; **1 All waste is sheeted on arrival and screen material on dispatch.** **2 Material should be processed promptly, within 48 hours if practicable or as a maximum within 5 days (FIFO) or stored to prevent anaerobic degradation or decay, amending the composting mixture as assessed.** **3 Waste is processed and monitored aggressively to address temperature and moisture as per section 3, 5 above to optimise the process.** **4 Slow speed shredders should be employed in sensitive locations with misting devices fitted where sae to do so or in covered areas.** **5 Weather data must be recorded and mitigation measures implemented at all times.** **6 Avoidance of particulate and bioaerosols forming activities, such as turning, screening and shredding in unfavourable meteorological conditions.** **7 Activity should cease if wind direction is toward the sensitive receptor. Misting and atomising units if used will be fully operational and maintained.** **8 Process monitoring and control measures should be in place to correct excessive temperatures and moisture control to control evaporation to minimise surface emissions off wastes.** **9 Haul roads and processing areas should be swept and damped down at least daily in dry conditions.** **10 Where possible static negative aeration should be considered or covered piles.** **<u>Enclosed Processes</u>** **11 The facility must be designed, constructed, commissioned, operated and maintained to a design specification as a minimum to prevent or minimise any potentially polluting point source and/or fugitive emissions. HAZOP management approach is considered best practice.** **12 A full and complete inventories of point source emissions must be made, including emergency events or planned maintenance.** **13 High levels of bioaerosols are always investigated. A Schedule 6 notice is submitted to**

the Regulator along with monitoring results as per permit conditions.

14 Where operators fail to control emissions, a full reassessment of the site must be made preferably by an independent and suitably qualified person. OMP and SSBRA documents are dynamic and need to be reviewed if processes change, tonnage increases or there are frequent and repetitive incidents of pollution or emissions above agreed and permitted limits. These must be reviewed as required or on a 12 monthly basis.

15 A programme of regular scheduled checks and maintenance and monitoring, must be developed and followed, including emergency events or planned maintenance.

7.4 Overview of Monitoring

A composting or aerobic treatment facilities are expected to submit a risk assessment based on H1 for instillations and for bespoke waste facilities where there is significant risk of odour or other airborne pollutants. An OMP will need to be submitted for operations with the permit application and agreed with the regulator. The frequency of odour monitoring if required would be set in the permit based upon the risk assessment and agreed OMP. Should emissions prove to be a problem then the permit can require the risk assessment and or OMP to be revised. In exceptional cases there may also be specific operational conditions relating to odour control which require certain techniques or specify emission limits.

Site staff must be trained to monitor for fugitive emissions such as dust, fibres, particulates, vapour releases and odours using their visual and olfactory senses. Where applicable the relevant British Standards should be used for monitoring e.g. British Standard 7445:1991 Description and measurement of environmental noise. In addition, dedicated monitoring equipment, strategically located, may be used to quantify emissions from the site. Different equipment is available dependent upon the type of monitoring or sampling required e.g. grab samples or continuous sampling.

The frequency of monitoring may be determined on the basis of results, seasonal considerations or specific activities being carried out. It may also be specified by the monitoring requirements of the site's environmental permit. All monitoring results need to be recorded to aid in the investigation of complaints and improving operational management. The results may have to be submitted to the regulatory authority, which is normally a requirement of the environmental permit.

The emissions are discussed in the following sections and where applicable relevant limits and standards are presented. In addition techniques and methodologies for the monitoring and abatement are discussed in terms of the advantages and disadvantages.

Further information on emissions monitoring is provided in the Environment Agency the Environment Agency Horizontal Guidance documents (see links in Appendix 12.4)

7.4.1 Bioaerosol Monitoring

Currently the standard for monitoring ambient level of bioaerosol are presented as agreed in the Environment Agency/AfOR Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities (AfOR 2009), available on the Organic Recycling web page (see links in Appendix 12.4). The protocol has been specifically developed for composting facilities that operate open-air turned-windrow systems composting green waste. Further revised guidance for monitoring from biowaste facilities will be available in 2014.

Sampling bioaerosols requires specialised equipment to both collect and analyse the samples and is described in the above guidance. Environment Agency staff must ensure that standardised protocols are followed by those undertaking bioaerosol monitoring. Where facilities are treating waste controlled under ABPR, monitoring for Gram-negative bacteria, is required as per permit requirements

7.4.2 Sampling Frequency for bioaerosols

The frequency of sampling for bioaerosols should be determined by the permit or the level of risk from a particular site. Where the level of bioaerosol emissions will initially be unknown, e.g. for new sites, frequent sampling (quarterly) should be undertaken, until the emissions and controls are well understood and evaluated as being compliant with the permit.

7.4.3 Odour Monitoring

It is expected that installations will have a well-documented monitoring plan. Monitoring can take several different forms depending on site type, location and location of sensitive receptors. These should be considered as part of the OMP (Odour Monitoring Plan):

- sniff testing (to check ambient air on or off site);
- meteorological monitoring - very simple, low risk, sites may monitor solely by indirect (e.g. local airfield met data) or observation methods, most, though, will require appropriately configured on-site data-logging instruments;
- complaints (direct complaints, as well as those made to the Environment Agency or a third party such as a local authority);
- odour diaries;
- surrogate chemicals or process parameters (e.g. H_2S, ammonia in emissions, and pH and liquor recirculation flow in a scrubber);
- emissions monitoring if there is a point of discharge to foul sewer;
- grab samples of source emissions that are subsequently diluted to the odour threshold in a laboratory setting (i.e. BS EN 13725 Dynamic Dilution Olfactometry);

Sniff testing is a common form of odour monitoring. While the factors mentioned in this section need to be taken into account in order to minimise inconsistencies, it can provide good evidence of an odour problem. Monitoring results will be improved if observers have been trained and understand their own sensitivities.

Example forms and advice for sniff testing and other useful forms are provided in the Environment Agency H4 Odour Horizontal Guidance.

The standard method for measuring odour in Europe is Dynamic Dilution Olfactometry (BS EN 13725:2003). This involves diluting a grab sample in a dedicated laboratory to a concentration at which half of an odour panel (of human sniffers with known sensitivity) can just detect the odour. So a dilution detection level of 10,000:1 would be a concentration of 10,000 odour units per m^3 (ouE/m3) (1ouE/m3 = the level of detection under laboratory conditions). This method is only suitable for more concentrated odour samples collected at source, which are relatively stable, as they need to be able to be detected by the human nose. If testing is carried out on highly variable emission sources, then the sampler will need to ensure that representative samples are taken. The BS provides information on the level of accuracy for the method which should be considered in these investigations. The use of accredited laboratories and sampling services is strongly recommended. A minimum of three odour samples are typically required to assess the variability of results.

Hedonic Tone Analysis is a sensory odour analysis technique that enables the relative offensiveness or pleasantness of odours to be determined. This technique can provide useful data for assessing the overall offensiveness of the odour produced by your facility and thereby assist in deciding the appropriate standard to use in modelling. A standard method (VDI 3882:1997, Part 2 Determination of Hedonic Tone) has been published by VDI Germany. See also Appendix 2 and Appendix 3 of the H4 Horizontal Guidance (link provided in Appendix 12.4).

7.4.4 Chemical Monitoring Techniques

A range of chemical monitoring techniques can be used under some circumstances. For example:

- Non-specific instruments (flame ionisation [FID], electrochemical detectors). Instruments that use a flame ionisation detector will respond to all volatile hydrocarbons, whether odorous or not. Therefore, the instrument may only give an indication of potential odour issues.
- Long path-length monitoring (e.g. LIDAR) also just measures Volatile Organic Compounds (VOCs) which indicate odour problems to the operator and loss of soluble carbon. It allows you to detect odour sources and take measurements across an emissions plume. Concentrations that are highly variable over a short period of time (i.e. seconds) probably come from nearby. More stable concentrations may suggest an emissions point which is further away. For ground level emissions it should be possible to move the monitor upwind of the suspected source to assess background levels. Some instruments allow for the quantitative assessment of dispersed emissions, as well as an assessment of relative emissions across a large area.
- Gold foil instruments are intended to measure extremely low levels of H2S (ppb range). But they are susceptible to interference from other gases and/or may also seriously underestimate the overall odour exposure if organosulphide chemicals (mercaptans) or other odorous chemicals .are present. Hydrogen sulphide instruments based on metal-oxide semiconductors will typically have sensitivities in the ppm range and so are limited to the assessment of relatively concentrated odour sources.
- A gas chromatograph mass spectrometer (GCMS) can, theoretically, be used to give speciation or a finger print of a particular chemical combination. However, the chemicals causing the odour are usually minor components (presenting very low concentrations) so that the results may not be representative of the odour.
- Electrochemical detectors (electronic noses) used in arrays may have applications in detecting a change of state in operating conditions as process controls. They are unlikely to be of value in measuring exposure in ambient air because they are not as “sensitive” as the human nose to a wide range of odours.

Chemical monitoring techniques such as continuous emissions monitoring, analysis of emissions grab samples and, sometimes, assessments of ambient air, may be useful as process controls. Where known, the investigator will need to consider the odour threshold of chemicals being investigated compared with the detection threshold of the analytical method being used. This a particular concern in the “chemical analysis” of highly odorous chemicals in ambient air where the human nose may be more sensitive than any analytical instruments.

Measuring Odour Surrogates and Process Controls

In a few cases, it is possible to monitor for odour surrogates. For example: odorous chemicals found as part of the mix (e.g. hydrogen sulphide or ammonia); non-odorous chemicals associated with odours (e.g. methane from landfills).

Process measurements, such as pH in a scrubber or the presence of anaerobic conditions in a composting windrow can be good indications of whether odour is under control.

With surrogate measurements, the key is that the ratio of surrogate concentration to odour units must be relatively constant and known. Most of the chemical instrumentation techniques listed above can be used to measure odour surrogates – that is they may be used to measure a single substance which is not actually the odorous chemical but is present in a constant relationship to it.

The information presented in this section should be read in conjunction with the Environment Agency H4 Odour Management Horizontal Guidance. The guidance provides further details and requirements regarding odour management that the developer will need to take into account when preparing an odour management plan.

7.5 Biofilters

Biofilters are filtration substrates, comprised of a substrate and micro-organisms that filter odorous air. They are used in the waste and composting industry as a primary mechanism for converting malodorous compounds into less odorous or odour free compounds. As the odorous process air passes through the biofilter substrate, odorous chemicals dissolve or attach to a water layer on the substrate and micro-organisms within the substrate mass metabolise the odour molecules before the air is discharged to atmosphere. That is, the micro-organisms population within the biofilter feeds off the odorous compounds passing through the biofilter.

Biofilters are designed based on the nominal volume of process air that they are required to filter. However, biofilters will require active management to keep them operating optimally. If a biofilter is accustomed to coping with moderate loadings on a continuous basis, it may struggle to cope with the occurrence of a sudden load, potentially resulting in a release of odorous gas. The ability of the biofilter to cope with this type of event will depend on its design characteristics, filter media and microbial populations. Operators should consider the potential loadings prior to site development in order to optimise operation of the biofilter.

Biofilters are the most common method of odour and off gas treatment at compost sites and with careful design and sizing can be efficient methods of treating air with relatively low levels of pollution loading. Biofilter costs are relatively low in comparison to other physical or chemical treatment methods, but they can have a high space or footprint requirement.

The basic design of a biofilter consists of biologically active media bed supported over an enclosed chamber that allows odorous gas to be fed into the filter media (fixed bed biofilter). Biofilters vary from relatively simple, open designs, to highly engineered closed systems. Enhancements to the basic biofilter design include biotrickling filters and bioscrubbers.

Biofilters may be of closed or open design, both of which work on the same principle:

- **Closed biofilters**, where the filtration medium is housed within a structure. This will typically have an inlet port for the untreated, odorous air, and an exhaust port for the treated air that has been through the filter.
- **Open biofilters**, where the medium is exposed to atmosphere, sometimes at the sides as well as the top. This will have an inlet port but filtered emissions will escape freely from the media mass on all exposed surfaces.

7.5.1 Biotrickling filter

A biotrickling filter is a modification to the trickling filter design used in waste water treatment. The process gas and liquid (commonly sewage) flow through a fixed bed either counter-currently or co-currently. The fixed bed material provides a surface for an aqueous biofilm to form in which biodegradation can occur. The bed is generally packed with an inert material such as structured plastics, resins, ceramics, celite, polyurethane foam, or lava rocks. The use of a synthetic media within the biofilter can provide benefits in that the system can be easily cleaned, result in a faster start-up, allow the system to handle high contaminant concentrations and give greater process control than basic biofilters.

A diagram of a simple bio trickling filter is provided in Figure 10.

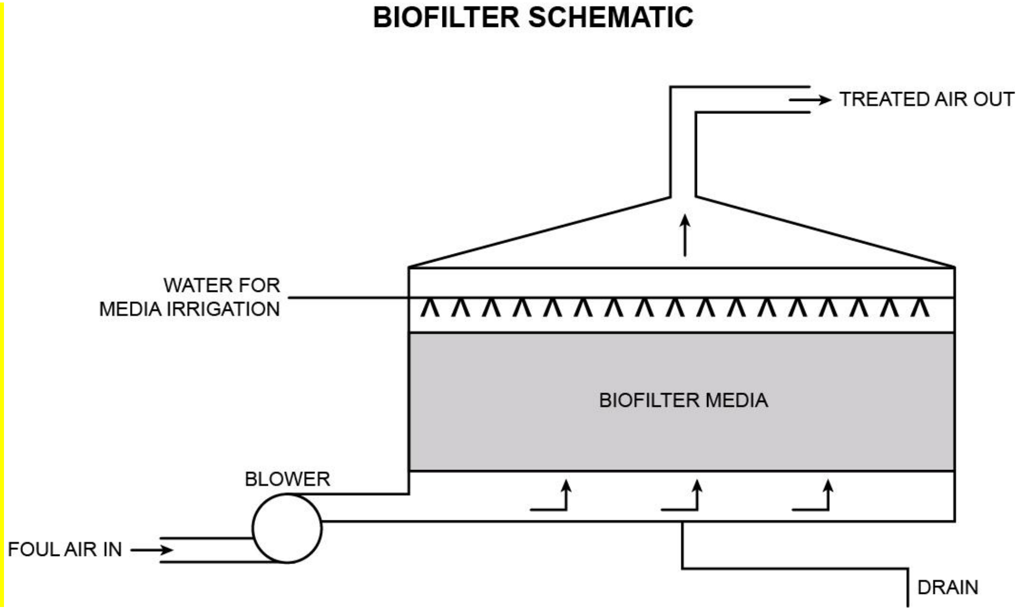


Figure 10: Bio trickling filter schematic diagram

The bioscrubber is an enhancement to the biotrickling filter. The bioscrubber attempts to improve the absorption of pollutants into the liquid phase, and lengthen the time the microbes have to consume the pollutants. These are accomplished in two ways: the tower packing is flooded with a liquid phase and the discharge effluent from the bioscrubber is collected in a storage tank (sump) before being recycled back to the bioscrubber. The bioscrubber may also offer improved process control over a conventional biofilter. The relative advantages and disadvantages of each biofilter treatment method are set out in Table 13.

7.5.2 Biofilter Operational Requirements

Maintaining optimal operational conditions is vital to ensure that a biofilter remains effective in treating fugitive odorous emissions. Operational considerations include:

Filter Media

The filter media to be used in a biofilter is an important consideration and must be selected to provide; adequate residence times, sufficient surface area (sorption capacity) for contaminants and microbial attachment, living space and reserve nutrients for microorganisms, water content, and structural support to maintain internal structure.

Materials that can be used as filter media include organic materials and wastes from a variety of sources, and inert materials for structural support and to aid adsorption capacity. Additives may be used to maintain optimum conditions such as limestone or crushed shells for pH maintenance.

Biodegradable filter media, such as woodchip would need to be replaced at intervals of dependant on the efficiency of odour removal. Inert beds, such as pumice stone or lava would last significantly longer and should be replaced in line with manufacturer’s recommendations.

Temperature

Temperatures in the range of 15–40 ºC are recommended for biofilter operation, but they can also provide effective abatement at slightly higher temperatures too. Rapidly fluctuating temperatures may adversely affect performance. In some situations it may be necessary to consider controlling the inlet air temperature and pre-cooling or heating may be required to maintain the optimal bed temperature for microbial activity.

Design	Advantages	Disadvantages
Fixed Bed Biofilter	Generally low operation, capital and maintenance costs. Maintenance can be reduced through the usage of lava or pumice media. Easy operation and start-up. High gas/liquid surface area	Large space requirement for traditional designs No continuous internal liquid flow in which to adjust bed pH or to add nutrients In an open design it is more difficult to obtain samples to prove effectiveness. Natural (biodegradable bed media such as wood chip must typically be replaced every 2 to 5 years depending on rate of flow and loading of gases - may need to be replaced more frequently. These can be expensive when the system relies solely on biofiltration
Biotrickling Filter	Good for high flow rates	Media may require regular replacement. Higher comparative capital costs.
Bioscrubber	Humidification of process gas is not required Smaller footprint than traditional biofilters pH and nutrient feed can be automated	Considerably more expensive to install and operate than other biofilter designs Overfeeding can lead to plugging Disappointing abatement results in UK applications on sewage odour

Table 10: Biofilter Design Advantages and Disadvantages (Source: review "Composting and Aerobic Treatment Technical Guidance – Literature Review" (EA/Jacobs, May 2012)

Moisture

Low moisture content or difficulties in controlling its level are the most common causes of poor biofilter operation. A moisture content that is too low can lead to bed desiccation and the development of fissures that cause short circuiting, which reduces effective capacity, residence time and process performance. Too much water inhibits the transfer of oxygen and hydrophobic pollutants to the biofilm, thereby promoting the development of anaerobic zones within the bed and limiting the reaction rate. Anaerobic zones can result in foul-smelling emissions. Excessive moisture can also cause unacceptably high pressure drops across the biofilter by limiting porosity.

Acidity

Most biofilters are designed to operate near to pH 7, although a large number of microorganisms are abundant and active in many natural ecosystems where the pH is lower or higher, and the pH of the medium must be adjusted to the optimum value in each case. Regulation of pH can be achieved by the addition of solid buffers (e.g., lime, calcium carbonate, and phosphate salts) to the packing material at the beginning of the operation, or by irrigating the bed with a nutrient solution that contains pH buffers (calcium and sodium hydroxide, and urea), or by additional irrigation. When addition of a buffer to the medium does not solve the problem or the capacity of the buffer is exhausted, the filter media may have to be removed and replaced with fresh material.

Nutrients

The filter media must contain all of the nutrients required to support microbial activity, such as carbon and nitrogen, as well as micro nutrients such as potassium and phosphorus. Due to the high concentration of ammonia and organic chemicals in gasses from compost operations, the addition of nutrients to biofilter media is not normally required. However provision should be made for addition of nutrients if required. Recommended Operational Conditions for Biofilters are detailed in Table 14.

Characteristic	Description
Filter media	Typically Biologically active, but reasonably stable
	Organic matter content >60 %, however mineral media have been successfully used.
	Porous and friable with 75 – 90 % void volume
	Resistant to water logging and compaction
	Relatively low fines content to reduce air pressure drop
	Relatively free of residual odour
	Specifically designed mixtures of materials may be desirable to achieve the above characteristics
Moisture content	50 – 80 % by weight
	Provisions must be made to add water and remove bed drainage
Nutrients	Must be adequate to avoid limitations
	Usually not a problem with aerobic digestion gases because of the high NH_3 content
pH	7 to 8.5
Temperature	Near ambient, 15 – 35 or 40 °C
Gas pre-treatment	Humidification could prove to be useful in order to achieve near 100 % inlet gas humidity. Pre-scrubbing with water or acid to remove high concentrations of ammonia may help control media pH.
	Dust and aerosols may be removed to avoid media plugging, but for most biofilters this is not a problem (unless they have a tissue/material filter layer in the bottom of the biofilter which could become blocked with dust particles)
Gas loading rate	<100 $m^3/h\text{-}m^3$, unless testing supports higher loadings
Gas residence time	Minimum of 45 seconds, unless testing supports shorter residence time
Media depth	>1m, <2 m to minimise pressure drops and operating costs
Elimination capacity	Depends on media and compound (typically in the range 10 – 160 g.m-3.h-1). Odour abatement in excess of 95% is possible with good designs and on-going management
Gas distribution	The manifold must be properly designed to present a uniform gas flow to the media

Table 11: Recommended Operational Conditions for Biofilters (source: EC, 2006)

7.6 Wet/ chemical scrubbers

There may be circumstances where wet chemical scrubbing is a suitable supplement or replacement for biofiltration in the removal of composting odours, for example when it is necessary to replace large volumes of air within a building due to elevated levels of ammonia. Chemical scrubbers may provide a better treatment option in the case where odour streams are highly variable, although this can lead to dosing instability. Additionally a chemical scrubber may not be as effective in the removal of volatile organic compounds as a biofilter.

Typically the area required for a chemical scrubber will be smaller than that for a biofilter, but due to the chemicals involved in the process there will be special handling and storage requirements on site.

The Industry Guide for prevention and control of odours (AFOR, 2007), states that wet chemical scrubbers provide intimate and prolonged contact between the treated air stream and an aqueous absorbing solution. A wide range of variations are possible including:

- Re-circulating and single-pass scrubbing solutions
- Acidic or alkaline scrubbing solutions
- Oxidising scrubbing solutions
- Packed column, plate or spray towers

Common chemicals used in wet scrubbing include oxidizing agents (sodium hypochlorite, hydrogen peroxide), bases (lime, hydrated lime, caustic), acids (sulphuric, hydrochloric), reducing agents and absorption enhancing agents.

Due to the complex nature of compost gases that include ammonia, organic sulphur compounds, and other organic compounds such as terpenes, different absorption conditions are necessary to remove all these compounds. Therefore single stage scrubbing may not be particularly effective and a multi-stage process is usually required. Examples of multi-stage scrubbing systems include misting towers (rarely very effective) and packed bed scrubbers.

Capital costs for these systems can be relatively high, particularly when equipped with systems to re-circulate and chemically dose the scrubbing solutions. However, their compact size, high potential removal efficiency and ability to handle highly variable air streams and loading rates can make them cost effective in some cases, particularly where high volumes of air require treatment (e.g. building ventilation) such as on a large scale In-vessel composting facility (AfOR, 2007).

Characteristic	Description
pH	Monitor away from chemical injection area
	Monitor as liquid exits packed bed
Chemical injection	As close to pump suction as possible
	Via a pipe with small perforations to optimise distribution
Acid growth	Minimise by acid washing or shock loading with sodium hypochlorite
	Use chlorinated system to destroy growth
	Use of UV light acts as a disinfectant
	Segregate all sources of phosphoric acid/phosphates
	Isolate VOC exhaust from scrubbed exhaust
	Use of sliding shades to prevent light entering system
Temperature	0- 40°C
Sump Liquid	Overflow or blow down methods – adequate recirculation rate should be achieved
	Recirculation rate must be sufficient to compensate for evaporation

Table 15 Optimal operational conditions for wet scrubbers

Activated carbon

Activated carbon is used in an adsorption process for odour removal from gas and is effective in humid gas streams providing the substrate is carefully monitored. Systems may use carbon adsorption following a water scrubbing process as activated carbon can be prone to plugging from dust and fine particulates. Activated carbon is not as effective at ammonia removal and therefore wet scrubbing to remove ammonia is required in addition to carbon adsorption where high nitrogen feedstocks are processed.

Recommended operational conditions for activated carbon are outlined in the table 16 below.

Characteristic	Description
Filter media	Porous and friable with 75 – 90 % void volume
	Resistant to water logging and compaction
	Relatively low fines content to reduce gas head loss
	Relatively free of residual odour
	Should ideally be changed every 2-3 months
Moisture content	Provisions must be made to remove bed drainage
pH	7 to 8.5
Gas pre-treatment	Humidification could prove to be useful in order to achieve near 100 % inlet gas humidity
Gas residence time	Min 4-6 seconds, unless testing supports shorter residence time
Elimination capacity	Depends on media and compound (typically in the range 10 – 160 g.m-3.h-1)
Gas distribution	The manifold must be properly designed to present a uniform gas flow to the media

Table 16 Recommended operational conditions for activated carbon

7.7 Ozone treatment

Ozone gas has been promoted as a means of treating malodorous air at composting sites. However, there is little supporting evidence of either the use of this technology by composting facilities or its efficacy in reducing odours from composting.

The ozone molecule (O_3) is a form of elemental oxygen which is widely used as a non-selective oxidising agent. Through oxidation it may change the malodorous compounds into a less odorous form and is itself reduced to O_2.

As with all odour control systems, operators should only install proprietary ozone systems on the basis of objective odour abatement performance guarantees (for example, measured using olfactometry), and in the light of successful objective odour abatement performance measured on similar plants.

7.8 Microbe Addition

It is the mass of the compost and how it is managed that determines microbe growth and reproductive rate. If conditions are optimised within the mass, microbes and fungi will reproduce. Any additional microbes or compounds should be geared to improving or increasing carbon and nutrient availability, improving pH or enhancing stress relief on microbiological populations.

These additions will generally be non-microbial and designed to maximize conditions for growth and reproduction within the mass. The success of these additives is based on correct application and rates of application and can be costly. They should not be used as a substitution for good practice and monitoring and management of the process.

7.9 Masking/Neutralising agents

The good practice of preventing the formation of odorous chemicals must override the principle of treating them once they have arisen. Deodorisers may be used to reduce odour detection off site, although the mechanism is poorly understood, it is claimed that odour compounds adhere to the neutralising compounds. The neutralising agent then dissolves the volatile organic compounds and combines with them to form a non-odorous compound (AfOR, 2007). To be effective the neutralising compost needs be form an aerosol and consideration should also be given to maintenance and the potential for legionella.

Deodorisers are applied by misting systems, which typically use compressed air. The efficacy of this technology may vary according to the proximity, dispersion and prevailing weather conditions and whether the facility is enclosed or open. The use of deodorisers should therefore only be used as part of a more comprehensive process management systems or emissions treatment plan.

These agents come in a variety of aromas including peppermint, strawberry and eucalyptus. These, in themselves, be considered offensive to some people if used over an extended period. This is reinforced by the Environment Agency's H4 guidance that states that masking agents that inhibit the recipients' sense of smell should not be used, and that perfumes are often perceived to be as offensive as the original odour and are simply adding another pollutant to the air.

7.10 Topical (localised) barriers

As volatile odorous chemicals migrate to the surface of a pile they can be dissolved in, or released from, available water in the form of surface moisture. Odours may be therefore be managed by the localised application of water. In order to take full advantage of this phenomenon, several conditions must be met:

- There must be sufficient water available to dissolve the chemicals;
- The solubility of chemicals should be optimised for the odours present. Volatile fatty acids will dissolve more freely in alkaline solutions while ammonia will dissolve more freely under acidic conditions; and
- An active aerobic biological community (e.g. bacteria, fungi, etc) can help to break down odorous chemicals once they are dissolved

Careful observation and application of water, potentially with the addition of an inexpensive neutral phosphate buffer, can help to optimise all of the above conditions. Too much water will reduce the availability of oxygen in the surface layer for aerobic microbes, while too little will not trap the odorous chemicals. Side-by-side testing of a number of proprietary topical treatments has demonstrated a wide range of effectiveness (AFOR, 2007) and therefore must not be considered a substitution for adopting process monitoring and management to prevent emissions.

7.11 Leachate management

Leachate can be generated from the compost feedstock where materials have high inherent water content and as they breakdown in the treatment process. This leachate may present potentially harmful characteristics such as soluble chemicals, nutrients, organic matter and pathogens.

Where excessive moisture penetrates a composting mass e.g. heavy rainfall or seasonal variation of waste, moisture can percolate through the composting mass allowing chemicals to dissolve into the leachate. The leachate has a high odour potential and should be actively managed.

Excess leachate may require disposal and depending upon the site location and available disposal routes may require onsite treatment. Leachate produced from waste containing animal by products will be treated as ABPR waste and will have to comply with ABPR regulation for treatment and disposal.

7.11.1 Leachate Monitoring

Leachate levels within storage vessels or lagoons should be monitored and arrangements for collection and off site treatment should be scheduled to reduce the likelihood of overfilling or overtopping. The operator should ensure that the storage facility and any drainage and sumps associated with it are de-sludged regularly to prevent both odours and a reduction in the capacity of the system and optimisation of aeration or agitation systems.

If discharged to water or sewer then the developer will be required, as part of the environmental permit application, to complete modelling which will be used to assess the impact of the discharge (refer to EA Horizontal Guidance H1 Annex D). Further discussion on leachate disposal is contained within Section 9.

7.11.2 Indicative BAT for leachate and liquor storage

Indicative BAT requirements for control of leachate and dirty water
Engineering
1. Impermeable pavement should be constructed in all operational areas of the facility, particularly in the case of composting pads or composting vessels but also including all storage, shredding and maturation areas. The design should be factored on worst case rain fall events.
2. Prevention of excessive leachate as a priority through design is needed, diverting rainfall from stored feedstock, active composting and product maturation areas where possible. The amounts collected can be minimised by providing separate drainage for clean roof water and clean yard water. Clean and dirty drainage should be clearly identified.
Storage
3 Leachate should be managed via a sealed drainage system that collects and separately contains it from non-contaminated surface water at the facility.
4 Open storage lagoon must provide at least 750mm of freeboard.
5 Leachate and other potentially polluting liquids should be directed to impermeable storage tanks or lagoons made either of concrete or manmade materials which are chemically compatible with the liquid they will contain e.g. such as HDPE (high density polyethylene)
6 All systems should be fitted with high level alarms and a record of inspection of levels kept on site.
7 Storage lagoons tanks should have adequate void space over a weekend or when high rainfall is predicted to prevent overtopping.
8 Underground leachate tanks will undergo non-destructive testing yearly or as directed by the supplier and identified in HAZOP.
9 Leachate levels within storage vessels should be monitored and arrangements for collection and treatment should be made in advance to reduce the likelihood of pollution.
10 As well as ensuring leachate is removed regularly the operator should ensure that the storage facility, and any drainage and sumps associated with it, are de-sludged regularly to prevent both odours and a reduction in the capacity of the system.
11 Reuse of leachate to maintain optimum moisture content in the active composting mix must take account of ABPR and avoid contamination. Leachate from unsanitised waste should not be applied to sanitised wastes.
12 Treatment of excess leachate to the necessary standard to enable it to be exported or discharged safely from site.
13 Discharge to foul sewer will require trade effluent consents.
14 Emergency failures and leaks on site should be notified to the regulator and/or utility provider immediately and alternative arrangement made as necessary.
15 A CCTV survey of drainage systems may be necessary as required by the permit.

16 Site records should be kept of treatment, deployment and disposal and should be submitted on waste returns.

7.12 Dust

Dust emissions may arise from composting activity or vehicle movements associated with the process. Dust formation from the compost generally occurs in material with a moisture content lower that 30%. This level is below the ranges discussed in Section 3.5.2.

7.12.1 Indicative BAT requirements for dust prevention and control

Indicative BAT requirements for dust prevention and control
The process and activities should be actively managed in order to reduce dust, this includes measures such as:
1 Regular monitoring of moisture content within the compost will assist with reducing dust emissions. At least daily during active treatment and weekly in maturation phases.
2 Using enclosed systems for reception, shredding and screening where sensitive receptors are with 250m of risk zones.
3 Implementing stringent loading bay door management.
4 Use of negative aeration and air treatment within enclosed reception and processing areas.
5 Reducing shredding, turning and screening of compost materials particularly on windy days.
6 Initiating dust suppression techniques including water mists and sprays and windbreaks.
7 Wetting and washing techniques – i.e. Damping down frequently during in dry weather, washing wheels of vehicles and roadways.
8 Barrier techniques – Sheeting, netting, covered transfers, windbreaks.
9 Direct clean up – rotary brush vacuum wagons, shaker bars.
10 Maintaining and cleaning of plant and machinery to avoid dust generation.
11 Sealing of roads particularly if traffic volumes are likely to be high.
12 Reducing on-site vehicle speeds, and
13 Paving of all operating, storage, loading and unloading areas.
14 Site records should be kept.

7.13 Litter

Loose packaging and litter can cause a significant impact on loss of amenity for nearby residents and health of local wildlife. Waste deliveries should arrive in enclosed or suitably sheeted vehicles and should not be discharged except within the waste acceptance and pre-treatment area or building. Litter can be problematic where feedstocks, particularly from local collection authorities, are from comingled collections.

7.13.1 Indicative BAT for prevention and remediation of litter

Indicative BAT requirements for litter prevention and control
The site should be actively managed in order to reduce litter. The following measures for the prevention of litter should be considered as a minimum.
1 Management procedures should be in place to ensure contrary material is promptly redirected to an appropriate facility.
2 Where that is not possible removal of litter contamination from feedstock material pre-processing.
3 Prompt disposal of any residual wastes.
4 Regular sweeping of roads and operational areas.
5 Minimising exposure of operational areas to prevailing winds.
6 Use of wind breaks, tree and shrub lines and static netting.
7 Use of mobile screens to intercept incidental litter.
8 Screening should aim to remove light contraries before final material is dispatched.
9 Screened out contraries shall be stored in a covered area and removed from site within 10 days.
10 Programme of litter picking on and around site throughout and at the end of each working day.
11 Potentially windblown materials or waste should not be unloaded or turned during windy conditions.
12 Site records should be kept and your management system should identify measures for litter control.

7.14 Vermin

Compost facilities, particularly open windrow operations, can attract vermin and in particular flies rodents and birds. It is possible for flies, birds to enter the building during waste delivery and accumulate in hot weather. Rats and other similar vermin may also gain access to the waste reception and pre-treatment building. These vermin, if not managed, can affect operations and create a negative perception of a composting facility. They pose an environmental and health hazard as a potential vector for pathogens, and can result in cross contamination between clean and dirty areas of a composting site, which could result in noncompliance with the ABP Regulations.

The presence of vermin and other vectors should be mitigated through effective housekeeping on site management of storage and tipping areas and processing areas. Animal by-product waste feedstock reception areas should be enclosed, except for when receiving deliveries as this can limit the entry of vermin.

If vermin are detected then immediate action needs to be taken to control the situation. This may be by instigating better housekeeping, clearing spillages etc. Where an infestation is likely, or occurs, it is recommended that professional pest control contractors are brought in to eradicate the problem immediately. Appropriate control measures need to be implemented to prevent a reoccurrence. All action taken must be recorded.

The agency has produced additional guidance for control of flies and this is listed in Appendix 12.

7.14.1 Indicative Bat for control and monitoring of vermin pests

Indicative BAT requirements for pest and Vermin control
The site should be actively managed in order to prevent and or reduce the presence of pests/ vermin, this includes as a minimum :
1 Rejection of malodour waste where possible.
2 Using enclosed delivery areas for food and catering waste is received stored or processed.
3 Isolating the materials, or wastes, that are attracting the scavengers and removing them to deter further scavengers and eradicate the scavengers from the site.
4 Instigating robust housekeeping, clearing spillages etc.
5 The incorporation and maintenance of adequate drainage to avoid pooling water.
6 Inspections being carried out weekly by a nominated person and the results recorded. All operatives should report any sightings to the nominated person immediately.
7 Taking immediate action on detection. Where identified as needing remedial measures inspection frequency should increase to daily.
8 Operators having written procedures for the inspection and control of vermin.
9 Where an infestation is likely, or occurs, it is recommended that professional pest control contractors are brought in to eradicate the problem immediately. Appropriate control measures need to be implemented to prevent a reoccurrence. All action taken must be recorded.
10 Records must be maintained and management systems up dated as necessary.

7.15 Noise

Excessive noise levels have the potential to cause nuisance to nearby residents due to loss of amenity and or interruption or loss of sleep. Aerobic compost operations present potential emissions from noise in respect of mechanical handling equipment such as shredders, turning equipment and front end loaders. In the case of certain In-vessel forced air blowers/driers and forced air compost systems, and, in the case of enclosed composting systems, active air extraction systems and loading and unloading of compost feedstock and product can all cause excessive noise. In the case of increased capacity or new facilities there may also be additional noise from traffic.

In the case of noise, “offence to any human senses” can normally be judged by the likelihood of complaints, but in some cases it may be possible to reduce noise emissions still further at reasonable costs and this may exceptionally therefore be BAT for noise emissions.

For advice on how noise and/or vibration related limits and conditions will be determined please refer to **H3 Part 1 Noise**

“Noise” should be taken to refer to “noise and/or vibration” as appropriate, detectable beyond the facility boundary. Where noise issues are likely to be relevant, the Operator will be required, to provide information on the following: (for more details see references)

- the main sources of noise and vibration that will fall within the facility and also on Infrequent sources of noise and vibration
- the nearest noise-sensitive sites
- conditions/limits imposed under other regimes

- the local noise environment
- any environmental noise measurement surveys, modelling or any other noise measurements
- any specific local issues and proposals for improvements

The level of detail supplied should be in keeping with the risk of causing noise-related annoyance at sensitive receptors.

Operations present potential emissions from noise in respect of mechanical handling equipment such as shredders, mobile plant such as shovels and extraction fans. In the case of increased capacity or new facilities there may also be additional noise from traffic and construction activities.

Planning applications for industrial facilities address noise using a British Standards BS 4142 noise assessment[1]. Findings of any such rating assessment can be used as part of an Environmental Permit application.

We have produced horizontal guidance on noise pollution (H3 Noise Assessment and Control). This guidance describes the principles of noise measurement and prediction, the control of noise by design and by operational and management techniques, abatement technologies and noise monitoring. The guidance assists in determining if proposals are BAT for a given facility and can be found in the Environmental Permitting Guidance section of our website (Appendix 12. 5). Design considerations and best management practice for minimising the emission of noise include:

- Incorporation of noise screening and cladding around particularly noisy site equipment;
- Attenuation provided by trees and hedges around boundary;
- Undertaking certain processing operations during normal working hours;
- Using mobile noise screens;
- Consideration of noise rating as part of equipment selection policy;
- Robust site management procedures to eliminate and reduce noise including routine operational noise assessment;
- Minimise use of noisy site equipment on windy days, where the prevailing wind direction is towards sensitive receptors; and
- Provision of personal protective equipment to employees where exposure to noise is potentially above 85 dB(A) average over eight hour working period.

7.15.1 Noise Monitoring

Operators should monitor the noise from site regularly, when it is fully working and also when it is shut down in order to provide a baseline for comparison. This will give an idea of the impact of work on the noise levels in the surrounding community. Monitoring will also help to identify any sensitive areas, changes in noise levels or specific spikes in noise levels. Additionally the routine monitoring of site noise will assist with demonstrating improvement if complaints are received, or to demonstrate compliance with specific limits.

[1]BS 4142:1997 - Method for rating industrial noise affecting mixed residential and industrial areas

7.15.2 Indicative BAT requirements for Noise and Vibration

Indicative BAT requirements for Noise and Vibration
1 Describe the main sources of noise and vibration (including infrequent sources); the nearest noise sensitive locations and relevant environmental surveys which have been undertaken; and the proposed techniques and measures for the control of noise. **2 The Operator should employ basic good practice measures for the control of noise, including adequate maintenance of any parts of plant or equipment whose deterioration may give rise to increases in noise (for example, bearings, air handling plant, the building fabric, and specific noise attenuation kit associated with plant or machinery).** **3 The Operator should employ such other noise control techniques necessary to ensure the noise from the facility does not give rise to reasonable cause for annoyance, in the view of the Regulator. In particular, the Operator should justify where Rating Levels (LAeq,T) from the facility exceed the numerical value of the Background Sound Level (LA90,T).** **4 Further justification will be required should the resulting field rating level (LAR,TR) exceed 50 dB by day and a facade rating level exceed 45 dB by night, with day being defined as 07:00 to23:00 and night 23:00 to 07:00.** **5 In some circumstances "creeping background" (i.e. creeping ambient) may be an issue. Where this has been identified in pre-application discussions or in previous discussions with the local authority, the Operator should employ such noise control techniques as are considered appropriate to minimise problems to an acceptable level within the BAT criteria.** **6 Noise surveys, measurements, investigations (e.g. on sound power levels of individual items of plant) or modelling may be necessary for either new or for existing facilities, depending upon the potential for noise problems. Where appropriate, the Operator should have a noise management plan as part of its management system.**

7.16 Light

Light pollution is defined as excessive or obtrusive light. There has been an increase in complaints about light to local authorities in recent years and lighting schemes may be included within the planning consent for a facility. If lighting is required then only the right amount of light for the task should be installed. Lighting will then only become a problem if it is poorly designed or incorrectly installed.

If lighting is necessary, a number of measures can be taken to avoid causing a nuisance:

7.16.1 Indicative BAT requirements for light pollution

Indicative BAT requirements for Light pollution
• **The Operator should employ basic good practice measures to ensure lights are correctly adjusted so that they only illuminate the surface intended and do not throw light onto neighbouring property.** • **Security lights should be correctly adjusted so that they only pick up the movement of persons in the area intended and not beyond.** • **To reduce the effects of glare, main beam angles of all lights should be below 70**

degrees. If uplighting has to be used then install shields or baffles above the lamp to reduce the amount of wasted upward light; and

- **Install equipment which does not spread light above the horizontal.**

7.17 Point source emissions to surface water, sewer and groundwater

7.17.1 Nature of effluent

The majority of point sources from `treatment facilities are in the form of leachate and treated digestate. Emissions to watercourses and groundwater (under consent) are rare and secondary treatment methods are required such as leachate treatment and reverse osmosis following by tertiary reed bed treatment may be necessary in order to meet environmental quality standards.

Consideration could be given to membrane processes, for example, micro-, ultra- and nano filtration. These are being utilised by some water utilities on discharges from WwTW, primarily to control pathogens. There would appear to be scope for the application of these filtration techniques (including sand filters) to remove particulate in effluent, reducing suspended solids.

It is important to note that, whereas a trade effluent consent for a discharge to sewer allows the release of a stated level of pollution, this does not necessarily mean that this is BAT for the treatment process. BAT requires that pollution should be prevented or reduced, within the cost and benefit framework of BAT.

The primary consideration should be to prevent releases of harmful substances to the aquatic environment, whether releases are direct or via sewage treatment works.

7.17.2 Indicative BAT requirements for point source emissions to surface water, sewer and groundwater

Indicative BAT requirements for point source emissions to surface water, sewer and groundwater
1 The following general principles should be applied in sequence to control emissions to water: **• water use should be minimised and wastewater reused or recycled** **• contamination risk of process or surface water should be minimised** **• wherever possible, closed loop cooling systems should be used and procedures in place to ensure blow down from abatement systems is minimised** **• where any potentially harmful materials are used all measures should be taken to prevent them entering the surface or ground water systems** **2 Consideration should be given to the use of treatment filtration/osmosis or other techniques which allow the effluent water to be cleaned, if discharge is to be to controlled waters.** **3 Where effluent is treated off-site at a sewage treatment works the above factors still apply. In particular, it should be demonstrated that:** **• action plans are appropriate to prevent direct discharge of the waste-waters in the event of sewer bypass, (via storm/emergency overflows or at intermediate sewage pumping stations) for example, knowing when bypass is occurring, rescheduling activities such**

Indicative BAT requirements for point source emissions to surface water, sewer and groundwater
as cleaning or even shutting down when bypass is occurring. • **a suitable monitoring programme is in place for emissions to sewer.** **4 The operator should conduct daily visual checks on the effluent management system and maintain a log.** **5 The operator should have in place procedures to ensure that the effluent specification is suitable for the on-site effluent treatment system or discharge criteria** **6 Measures should be in place to isolate effluent where samples indicate a breach of specification. Incidents of this nature should be recorded in the effluent log.**

7.17.3 Point source emissions to groundwater

In general, there should be no permitted releases to groundwater of either direct or indirect nature.

On 6 April 2010 the controls to protect groundwater quality formerly dealt with under the transitory Groundwater regulations 2009 (which superseded the Groundwater regulations 1998) came within phase 2 of environmental permitting regime via the Environmental Permitting (England and Wales Regulations 2010. EPR 2010 implements the requirements for controls on discharges to groundwater imposed by the Water Framework Directive.

EPR also replaces the offences under previous regulations and the Water Resources Act 1991 for the discharge of pollutants without a permit. Anything defined as a groundwater activity now requires either an environmental permit or must be an exempt groundwater activity. It is an offence to operate a regulated facility or to cause or knowingly allow a groundwater activity to take place without an environmental permit or an exemption.

Point source pollution of groundwater is localised and comes mostly from for example, spills, leaks, accidents, uncontrolled discharges and emissions from industrial plants. Pollution occurs if there is actual or likely harm to receptors, such as nearby abstractions, groundwater dependent wetlands or base flow fed surface waters, and of course the current or future potential use of groundwater itself. Harm would be judged against the risk that a relevant environmental standard would be exceeded.

The Water Framework Directive (2000/60/EC) introduced the concept of ‘hazardous substances’ and ‘non-hazardous pollutants’, which replaced the previous definitions of List I and List II substances in the now revoked Groundwater Regulations. Hazardous substances are defined as ‘substances or groups of substances that are toxic, persistent and liable to bio-accumulate, and other substances or groups of substances that give rise to an equivalent level of concern.’ All substances previously confirmed to be on List I are automatically considered to be hazardous substances subject to any re-classification. The UK is required under the Groundwater Daughter Directive (2006/60/EC) to publish a list of substances it considers hazardous. This list is determined by the Joint Agencies Groundwater Directive Advisory Group (JAGDAG). Non-hazardous pollutants include any substance capable of causing pollution. Note that the range of non-hazardous pollutants is now much wider than those contained on the previous List II.

In England and Wales, the inputs of hazardous substances and non-hazardous pollutants to groundwater are controlled via the EPR (2010). An input is any entry of a substance into groundwater from an activity or discharge, whether accidental or deliberate, point source or a diffuse source, that causes a release of a pollutant into groundwater. Inputs can be direct or non-direct:

- A direct input is defined as 'the introduction of a pollutant to groundwater without percolation through soil or subsoil.'
- An indirect input is characterised by the discharge into groundwater after percolation through the soil or subsoil.

Inputs of hazardous substances must be prevented from entering groundwater; inputs of non-hazardous pollutants into groundwater must be limited. The direct input of hazardous substances to groundwater is not permitted by regulation unless it satisfies certain specific criteria.

To 'prevent' an input into groundwater means taking all measures deemed necessary and reasonable to avoid the entry of hazardous substances into groundwater. While it is technically difficult to demonstrate that no hazardous substances will enter groundwater, the practical interpretation is that hazardous substances should not be discernible above the natural background groundwater quality. Any deliberate discharge of non-hazardous pollutants need to be controlled via an environmental permit and must not cause pollution.

For more information, interpretation and key definitions (for England and Wales) see Groundwater Protection: Principles and Practice (GP3) Environment Agency, 2012.

EPR Horizontal Guidance note H5 'Site Condition Report – Guidance and Templates' provides guidance for operators of new and existing operations where there may be a significant risk to land or groundwater. A Site Condition Report describes and records the condition of the land and groundwater at a site. It enables operators to demonstrate that they have protected groundwater during the lifetime of the site and it is in a satisfactory state when they come to surrender their permit.

7.17.4 Indicative BAT requirements for point source emissions to groundwater

Indicative BAT requirements for point source emissions to groundwater
1 In general, there should be no permitted releases to groundwater of either a direct or indirect nature. **2 If there are releases to groundwater and they are to continue, the requirements of the Regulations, as summarised above, must be complied with.**

7.18 Fugitive Emissions to surface water, sewer and groundwater

There should be no fugitive releases to surface or groundwater other than clean runoff. Appropriate steps should be taken to ensure runoff remains uncontaminated. Some common examples of sources of fugitive releases to waters and their preventive measures are given in the BAT box below.

7.18.1 Indicative BAT requirements for fugitive emissions to surface water, sewer and groundwater

Indicative BAT requirements for emissions of substances not controlled by emission limits to surface water, sewer and groundwater
1 For subsurface structures: • **establish and record the routing of all facility drains and subsurface pipe work and label these;** • **engineer systems to minimise leakages from pipes and ensure swift detection if they do occur, particularly where polluting substances are involved;** • **provide secondary containment and/or leakage detection for sub-surface pipe work, sumps and storage vessels;** • **establish an inspection and maintenance programme for all subsurface structures, e.g. Pressure tests, leak tests, material thickness checks or CCTV** **2 All sumps should:** • **be impermeable and resistant to stored materials;** • **be subject to regular visual inspection and any contents pumped out or otherwise removed after checking for contamination;** • **where not frequently inspected, be fitted with a high level probe and alarm, as appropriate;** • **be subject to programmed engineering inspection (normally visual, but extending to water testing where structural integrity is in doubt).** **3 For surfacing:** • **design appropriate surfacing and containment or drainage facilities for all operational areas, taking into consideration collection capacities, surface thicknesses, strength/reinforcement; falls, materials of construction, permeability, resistance to chemical attack, and inspection and maintenance procedures;** • **have an inspection and maintenance programme for impervious surfaces and containment facilities;** • **unless the risk is negligible, have improvement plans in place where operational areas have not been equipped with:** **– an impervious surface** **– spill containment kerbs** **– sealed construction joints** **– connection to a sealed drainage system** **4 All above-ground tanks containing liquids should be bunded. Bunds should:** • **be impermeable and resistant to the stored materials;** • **have no outlet (that is, no drains or taps) and drain to a blind collection point;** • **have pipe work routed within bunded areas with no penetration of contained surfaces;** • **be designed to catch leaks from tanks or fittings;**

Indicative BAT requirements for emissions of substances not controlled by emission limits to surface water, sewer and groundwater
• **have a capacity greater than 110 percent of the largest tank or 25 percent of the total tankage, whichever is the larger;** • **be subject to regular visual inspection and any contents pumped out or otherwise removed under manual control after checking for contamination;** • **where not frequently inspected, be fitted with a high-level probe and an alarm, as appropriate;** • **where possible, locate tanker connection points within the bund, otherwise provide adequate containment;** • **be subject to programmed engineering inspection (normally visual, but extending to water testing where structural integrity is in doubt) be designed, constructed and maintained to meet with the specifications outlined in the Construction Industry Research and Information Association guidance document titled 'CIRIA 164.'**

8 Energy efficiency

8.1 Energy and BAT

Energy efficiency measures are required for composting and aerobic treatment subject to regulation as a facility activity. A number of these measures will also be relevant to facilities as a waste operation. Operators should take proportional steps to ensure that the facility is designed and operated in such a way as to optimise energy efficiency.

8.2 Basic energy requirements (1)

The BAT requirements of this section are basic low-cost energy standards that apply in all cases.

8.2.1 Indicative BAT requirements for Basic Energy Requirements

Indicative BAT requirements for Basic Energy Requirements
1 The Operator should provide the energy consumption information in terms of delivered energy and consumption All this information should be submitted in the application (in England and Wales the H1 software tool should be used to produce this information). The Operator should also provide energy flow information (such as “Sankey” diagrams or energy balances) showing how the energy is used throughout the process.
2 The Operator should provide the following Specific Energy Consumption (SEC) information. Define and calculate the SEC of the activity (or activities) based on primary energy consumption for the products or raw material inputs that most closely match the main purpose or production capacity of the facility. Provide a comparison of SEC against any relevant benchmarks available for the sector. (See Energy Efficiency Guidance)
3 The Operator should provide associated environmental emissions. This is dealt with in the Operator’s response to the emissions inventory using the H1 software tool.

The Energy Efficiency Guidance Note provides an appraisal methodology. If Operators use other appraisal methodologies they should state the method in the Application, and provide evidence that appropriate discount rates, asset life and expenditure (£/t) criteria have been employed.

The energy efficiency plan is required to ensure that the Operator has considered all relevant techniques. However, where a CCA or DPA is in place the Regulator will only enforce implementation of those measures in categories 1-3 above.

8.2.2 Basic energy requirements (2)

The BAT requirements of this section are basic low-cost energy standards that apply in all cases.

8.2.3 Indicative BAT requirements for Basic energy requirements (2)

Indicative BAT requirements for Basic Energy Requirements (2). Describe the proposed measures for improvement of energy efficiency.
1 Operating, maintenance and housekeeping measures should be in place in the following areas, where relevant: (Indicative checklists of appropriate measures are provided in Appendix 2 of the guidance note H2 Energy efficiency.) **• air conditioning, process refrigeration and cooling systems (leaks, seals, temperature control, evaporator/condenser maintenance)** **• operation of motors and drives** **• compressed gas systems (leaks, procedures for use)** **• steam distribution systems (leaks, traps, insulation)** **• space heating and hot-water systems** **• lubrication to avoid high-friction losses** **• heat exchange systems** **• other maintenance relevant to the activities within the facility** **2 Basic low-cost physical techniques should be in place to avoid gross inefficiencies. These should include insulation, containment methods, (such as seals and self-closing doors), and avoidance of unnecessary discharge of heated water or air (e.g. by fitting simple control systems such as timers and sensors).** **3 Energy-efficient building services should be in place to deliver the requirements of the Building Services section of the guidance note H2 Energy efficiency for IPPC. For energy intensive industries these issues may be of minor impact and should not distract effort from the major energy issues, but they should nonetheless find a place in the programme, particularly where they constitute more than 5 percent of the total energy consumption.** **4 Energy management techniques should be in place, in particular, the need for monitoring of energy flows and targeting of areas for reductions.** **5 An energy efficiency plan should be provided that:** **• identifies all techniques relevant to the facility,** **• estimates the CO_2 savings that would be achieved by each measure over its lifetime**

The Energy Efficiency Guidance Note provides an appraisal methodology. If Operators use other appraisal methodologies they should state the method in the Application, and provide evidence that appropriate discount rates, asset life and expenditure (£/t) criteria have been employed. The energy efficiency plan is required to ensure that the Operator has considered all relevant techniques. However, where a CCA or DPA is in place the Regulator will only enforce implementation of those measures in categories 1-3 above.

8.3 Further energy efficiency requirements

The operator should demonstrate the degree to which the further energy-efficiency measures identified in the implementation plan, including those below, have been taken into consideration for this sector and justify where they have not.

8.3.1 Indicative BAT requirements for further energy efficiency requirements

Indicative BAT requirements for further energy efficiency. Climate Change Agreement or Trading Agreement.
1 The following techniques should be implemented where they are judged to be BAT based on a cost/benefit appraisal according to the methodology provided in Appendix 4 of the Guidance Note H2 Energy efficiency for IPPC. **Energy supply techniques** **2 The Operator should provide justification that the proposed or current situation represents BAT, irrespective of where there are other BAT considerations involved, e.g.:** **• the choice of support fuel impacts upon emissions other than carbon dioxide, e.g. sulphur dioxide;** **• the potential for practical energy recovery from waste conflicts with energy efficiency requirements.**

9 Management

9.1 Management Systems

We require implementation of an effective management system for ensuring that all appropriate pollution prevention and control techniques are delivered reliably and on an integrated basis.

We support the operation of formal environmental management systems (EMSs) but equally will accept non-certified systems. The level of information and control should be proportional to the risk each activity may have to the environment or on process control. An operator with such a system will not only find it easier to meet the BAT requirements for management of the facility but also many of the technical/regulatory requirements listed in other sections of this guidance.

We recommend either certification to the ISO 14001 standard or registration under EMAS (EC Eco Management and Audit Scheme) (OJ L114, 24/04/01). Both certification and registration provide independent verification that the EMS conforms to an auditable standard. EMAS now incorporates ISO 14001 as the specification for the EMS element, and we consider that overall EMAS has a number of other benefits over ISO14001 - including a greater focus on environmental performance, a greater emphasis on legal compliance, and a public environmental statement. For further details about ISO 14001 and EMAS contact British Standards Institute (BSI) or the Institute of Environmental Management and Assessment (IEMA), respectively.

Whilst an effective EMS will help the operator to maintain compliance with specific regulatory requirements and manage all significant environmental impacts, this section of the guidance identifies only those EMS requirements that are not specifically covered elsewhere in the document. This Section should not, therefore, be taken to describe all of the elements of an effective environmental management system. The requirements below are considered to be BAT, but they are the same techniques required by a formal EMS and so should be capable of delivering wide environmental benefits.

The Environment Agency provides Horizontal guidance for the use of Environmental Management Systems (guidance note H6). Appendix 12.4 includes a link to this guidance.

The European Commission has also set out its views on BAT and Environmental Management Systems in the form of standard text which will be included in all new and updated BREFs.

Your management system must include information about the condition of the land before you start operations, and how you have protected it during the life of the permit and site closure. When you come to apply to surrender your permit, you will need to be able to show you have taken the necessary measures to avoid any pollution risk resulting from your activities and the site has been returned to a satisfactory state.

The Environment Agency also provides Horizontal guidance for ‘H6 Environmental Management Systems’ guidance is provided in the link included in Site Condition Reporting (guidance note H5). Appendix 12.5 includes a link to this guidance.

9.2 Technical Competence

We require operators holding environmental permits to be competent to deal with the environmental risks associated with their activities throughout the life of the permit.

Operators should ensure that staff are suitably trained and qualified for the management and operation of a composting facility. Any facility undertaking a specified waste management activity under an Environmental Permit must be operated by suitable technically competent management in accordance with an approved competence scheme. This is a mandatory requirement.

Further details on the requirements for technical competence can be found in our Regulatory Guidance Note No.5: Operator Competence (see links in Appendix 12.4).

9.2.1 Indicative BAT requirements for Management Systems and technical competence

Indicative BAT requirements for Management Systems
<u>Operations and maintenance</u> **1 Effective operational and maintenance systems should be in use for all aspects of the process especially where failure could impact on the environment, in particular there should be:** • **documented procedures to control operations that may have an adverse impact on the environment** • **a defined procedure for identifying, reviewing and prioritising items of plant for which a preventative maintenance regime is necessary (HAZOP)** • **documented procedures for monitoring emissions or impacts** • **a preventative maintenance programme covering all plant, whose failure could lead to impact on the environment, including regular inspection of major 'non-productive' items such as tanks, pipe work, retaining walls, bunds, ducts and filters** **2 The maintenance system should include auditing of performance against requirements arising from the above and reporting the result of audits to top management.** **<u>Competence and training</u>** **3 Training systems, covering the following items, should be in place for all relevant staff which cover** • **awareness of the regulatory implications of the Permit and how this impacts their work responsibilities and activities;** • **awareness of all potential environmental effects from operation under normal and abnormal or extreme circumstances (e.g. extreme weather, plant failure, emergency)** • **awareness of the need to report deviation from the Permit** • **prevention of accidental emissions and action to be taken when accidental emissions occur** • **reporting and accountability procedures within the management structure of the facility** **4 The skills and competencies necessary for key posts should be documented and records of training needs and training received for these post maintained.** **5 The key posts should include contractors and those purchasing equipment and materials** **6 The potential environmental risks posed by the work of contractors should be assessed and instructions provided to contractors about protecting the environment while working on site.** **7 Where industry standards or codes of practice for training exist (e.g. WAMITAB) they should be complied with.**

Indicative BAT requirements for Management Systems
<u>Accidents/incidents/non-conformance</u> **8 There should be an accident plan which:** • **identifies the likelihood and consequence of accidents and emergency** • **identifies actions to prevent accidents and mitigate any consequences** **The accident management plan should consider and have procedures for dealing with events which effect the day to day operation of the facility e.g. risks and impact of flooding and fires** **9 There should be written procedures for handling, investigating, communicating and reporting actual or potential non-compliance with operating procedures or emission limits.** **10 There should be written procedures for handling, investigating, communicating and reporting environmental complaints and implementation of appropriate actions.** **11 There should be written procedures for investigating incidents, (and near misses) including identifying suitable corrective action and following up procedures.** **<u>Organisation</u>** **The following are indicators of good performance** **12 The company should adopt an environmental policy and programme which:** • **includes a commitment to continual improvement and prevention of pollution;** • **includes a commitment to comply with relevant legislation and other requirements to which the organisation subscribes; and** • **identifies, sets, monitors and reviews environmental objectives and key performance indicators independently of the permit** **13 The company should have demonstrable procedures (e.g. written instructions) which incorporate environmental considerations into the following areas:** • **the control of process and engineering change on the facility;** • **design, construction and review of new facilities and other capital projects (including provision for their decommissioning);** • **capital approval; and** • **purchasing policy.** **14 The company should conduct audits, at least annually, to check that all activities comply with procedures (as above) and the Permit. Preferably, these should be independent accredited auditing body.** **15 The company should report annually on environmental performance, objectives and targets, and future planned improvements. Preferably, these should be published environmental statements.** **16 Preferably a formal Environmental Management System should be a registered or certified EMAS/ISO 14001 system (issued and audited by an accredited certification body).** **17 The company should have a clear and logical system for keeping records of, amongst others:** • **policies**

Indicative BAT requirements for Management Systems
roles and responsibilities   **targets**   **procedures**   **results of audits**   **results of reviews**   **<u>Closure</u>** **18 Operations during the life of the Permit should not lead to any deterioration of the site Should any instances arise which have, or might have, impacted on the state of the site, the Operator should record them along with any further investigation or ameliorating work carried out. This will ensure that there is a coherent record of the state of the site throughout the life of the Permit. This is as important for the protection of the operator as it is for the protection of the environment** **19 Your management system must include information about the condition of the land before you start operations and how you have protected it during the life of the permit and plans for site closure** **<u>Steps to be taken at the design-and-build stage of the activities</u>** **20 Care should be taken at the design stage to minimise risks during decommissioning. Designs should ensure that:**   **underground tanks and pipework are avoided where possible (unless protected by secondary containment or a suitable monitoring programme)**   **any underground pipes and vessels will have detailed plans including shut off and emergency vales**   **there is provision for the draining and clean-out of vessels and pipework prior to dismantling**   **lagoons are designed with a view to their eventual clean-up or surrender**   **insulation can readily dismantled without dust or hazard**   **materials used are recyclable where possible (having regard for operational or other environmental objectives)**   **allows the complete removal or the flushing out of pipelines and vessels emptying any potentially harmful contents**

9.3 Raw materials selection

The process of selecting raw materials can present an opportunity to control emissions at source so, in this regard; the range of possible raw material options should be carefully examined.

An Application for a Permit should contain a list of the materials in use which have potential for significant environmental impact, together with the following associated information:

- the chemical composition of the materials, where relevant
- the quantities used

- the fate of the material in the facility (i.e. approximate percentages to each environmental medium and to the products)
- the environmental impact potential, where known (e.g. degradability, bioaccumulation potential, toxicity to relevant species)
- any reasonably practicable alternative raw materials that may have a lower environmental impact (including, but not limited to, any alternatives described in the BAT requirements below) on the substitution principle
- and justification for the continued use of any substance for which there is a less hazardous alternative (e.g. on the basis of impact on product quality) to show that the proposed raw materials are therefore BAT

Typically an aerobic composting process may use a Bulking Agent material to create a self-supporting structure which maintains air spaces and therefore airflow within the heap. Bulking Agents can include grade A wood chip, wood bark.

There might be other reagents depending on the nature of the aerobic composting process and these should be identified by the operator.

Other legislation may apply to raw material storage such as COMAH and COSHH Please refer to Appendix 12.4 for links to HSE guidance related to both COMAH and COSHH.

9.3.1 Indicative BAT requirements for Raw Materials Selection

Indicative BAT requirements for Raw Materials Selection
1 The Operator should maintain a list of raw materials and their properties as noted above
2 The Operator should have procedures for the regular review of new developments in raw materials and for the implementation of any suitable ones with an improved environmental impact
3 The Operator should have quality-assurance procedures for controlling the impurity content of raw materials
4 The Operator should complete any longer-term studies needed into the less polluting options and should make any material substitutions identified

9.4 Waste minimisation audit (minimising the use of raw materials)

Waste minimisation can be defined simply as: "a systematic approach to the reduction of waste at source, by understanding and changing processes and activities to prevent and reduce waste". A variety of techniques can be classified under the term waste minimisation, from basic housekeeping through statistical measurement, to application of clean technologies.

In the context of waste minimisation and this Guidance, waste relates to the inefficient use of raw materials and other substances at a composting facility. A consequence of waste minimisation will be the reduction of gaseous, liquid and solid emissions. Key operational features of waste minimisation will be:

- the ongoing identification and implementation of waste prevention opportunities
- the active participation and commitment of staff at all levels including, for example staff suggestion schemes
- monitoring of materials' usage and reporting against key performance measures

For the primary inputs to activities which are themselves waste activities, e.g. composting, the requirements of this section may have been met “upstream” of the facility. However, there may still be arisings that are relevant.

9.4.1 Indicative BAT requirements for Waste Minimisation (minimising the use of raw materials)

Indicative BAT requirements for Waste Minimisation(minimising the use of raw materials)
In the context of waste minimisation and this Guidance, waste relates to the inefficient use of raw materials and other substances at a composting facility. A consequence of waste minimisation will be the reduction of gaseous, liquid and solid emissions. Key operational features of waste minimisation will be: • **the ongoing identification and implementation of waste prevention opportunities** • **the active participation and commitment of staff at all levels including, for example staff suggestion schemes** • **monitoring of materials’ usage and reporting against key performance measures**

9.5 Water use

Potable water used for cleaning should be minimised. Grey water should be utilised where possible to reduce use of potable water. The benefits to be gained from reducing water input include: cost savings where water is purchased. The use of a simple mass balance for water use should help to reveal where reductions can be made.

9.5.1 Indicative BAT requirements for Water Use

Indicative BAT requirements for Water Use
1 The Operator should carry out a regular review of water use (water efficiency audit) at least every 4 years. If an audit has not been carried out in the 2 years prior to submission of the application and the details made known at the time of the application, then the first audit should take place within 2 years of the issue of the Permit • **flow diagrams and water mass balances for the activities should be produced.** • **water-efficiency objectives should be established, with focus on reducing water use and maximising reuse** **2 Within 2 months of completion of the audit, the methodology used should be submitted to the Regulator, together with proposals for a time-tabled plan for implementing water reduction improvements for approval by the Regulator** **3 The following general principles should be applied in sequence to reduce emissions to water:** • **water-efficient techniques should be used at source where possible** • **water should be recycled within the process from which it issues**

- **in particular, if uncontaminated roof and surface water cannot be used in the process, it should be kept separate from other discharge streams, at least until after the contaminated streams have been treated in an effluent treatment system and been subject to final monitoring**

4 The water-quality requirements associated with each use should be established, and the scope for substituting water from recycled sources identified and input into the improvement plan

5 Water usage for cleaning and washing down should be minimised by:

- **vacuuming, scraping or mopping in preference to hosing down;**
- **reusing wash water (or recycled water) where practicable;**
- **using trigger controls on all hoses, hand lances and washing equipment.**

6 Fresh water consumption should be directly measured and recorded regularly at every significant usage point - ideally on a daily basis.

9.6 Waste Recovery or Disposal

The Waste (England and Wales) Regulations 2011 require the Regulator, through update to the Environmental Permitting Regulations (England and Wales) 2010 to set permit conditions to ensure that the waste hierarchy as set out in the Waste Framework Directive (2008/98/EC) is applied to wastes generated by a waste operation. Aerobic composting facilities are must be managed in accordance with the waste hierarchy as set out in Article 4 to the Directive, namely that the following steps shall apply as a priority order in waste prevention and management legislation and policy:

- prevention;
- preparing for re-use;
- recycling;
- other recovery, e.g. energy recovery; and
- disposal.

The objectives of the National Waste Strategies should also be considered.

9.6.1 Indicative BAT requirements for Waste Recovery or Disposal

Indicative BAT requirements for Waste Recovery or Disposal
1 Waste production should be avoided wherever possible. Any waste that is produced should be recovered, unless it is technically or economically impractical to do so. **2 Where waste must be disposed of, the Operator should provide a detailed assessment identifying the best environmental options for waste disposal - unless the Regulator agrees that this is unnecessary. For existing disposal activities, this assessment may be carried out as an improvement condition to a timescale to be approved by the Regulator.** **3 Drums and IBC's should be designed, manufactured and marked to enable reconditioning /refurbishment. As such 205 litre drums, 800 and 1000 litre IBCs should be cleaned and reconditioned to enable re-use where technically and economically possible.**

4 Containers that cannot be re-used where there is no reconditioning market and which have been cleaned can be released into the secondary materials market.

9.7 Accidents

This section covers accidents and their consequences. It is not limited to major accidents but includes spills and abnormal operation. Some facilities will also be subject to the Control of Major Accident Hazards Regulations 1999 (COMAH), IPPC and COMAH can sometimes overlap, and some systems and information may be usable for either regime.

The main risks to the environment are:

- loss of containment of waste liquors or digestate. This has a very high biological oxygen demand which can render water bodies anoxic and damage ecosystems. Pathogens associated with the waste inputs may also be released to the environment.
- Uncontrolled release of gases which may result in complaints about odour and more importantly, risk of explosion and/or asphyxiation.

For accident management, there are three particular components:

- identification of the hazards posed by the facility/activity
- assessment of the risks (hazard x probability) of accidents and their possible consequences
- implementation of measures to reduce the risks of accidents, and contingency plans for any accidents that do occur

9.7.1 Indicative BAT requirements for accidents and abnormal operation

Indicative BAT requirements for accidents and abnormal operation
1 A formal structured accident management plan should be in place which covers the following aspects: **Identification of the hazards to the environment using a methodology such a HAZOP study. Areas to consider should include, but not be limited to, the following:** • **storage areas** • **arrangements for the receipt, and checking of incoming wastes, including rejection and quarantine** • **arrangements for the storage, segregation and separation of differing waste types** • **procedures for the internal transfer, including "bulking-up", of waste materials** • **transfer of substances (e.g. filling or emptying of vessels)** • **emissions from plant or equipment (e.g. leakage from joints, over-pressurisation of vessels, blocked drains)** • **failure of containment (e.g. physical failure or overfilling of bunds or drainage sumps)** • **failure to contain fire waters** • **wrong connections made in drains or other systems**

Indicative BAT requirements for accidents and abnormal operation
• **incompatible substances allowed to come into contact with sensitive receptors** • **unexpected reactions or unplanned reactions** • **release of an effluent before adequate checking of its composition or permission** • **failure of main services (e.g. power, steam, cooling water)** • **operator error** • **vandalism** **3 Assessment of the risks once the hazards have been identified, the process of assessing the risks should address six basic questions:** • **how likely is the particular event to occur (source frequency)?** • **what substances are released and how much of each (risk evaluation of the event)?** • **where do the released substances end up (emission prediction - what are the pathways and receptors)?** • **what are the consequences (consequence assessment – what are the effects on the receptors)?** • **what are the overall risks (determination of overall risk and its significance to the environment)?** • **what can prevent or reduce the risk (risk management – measures to prevent accidents and/or reduce their environmental consequences)?** **4 The depth and type of assessment will depend on the size of the waste types handled and its location. The main factors to take into account are:** • **the scale and nature of the accident hazard presented by the facility** • **the risks to areas of population and the environment (receptors)** **5 Identification of the techniques necessary to reduce the risks. The following techniques are relevant to most facilities:** • **there should be an up-to-date inventory of substances, present or likely to be present, which could have environmental consequences if they escape.** • **where the facility is situated in a floodplain, consideration should be given to techniques which will minimise the risk of the flooding causing a pollution incident or making one worse.** • **security systems to prevent unauthorised access should be provided where appropriate.** • **there should be formal systems for the logging and recording of all incidents, near misses, abnormal events, changes to procedures and significant findings of maintenance inspections.** • **there should be procedures for responding to and learning from incidents, near-misses, etc.** • **the roles and responsibilities of personnel involved in incident management should be formally specified.** • **clear guidance should be available on how each accident scenario might best be**

Indicative BAT requirements for accidents and abnormal operation
managed(e.g. containment or dispersion, to extinguish fires or to let them burn). • procedures should be in place to avoid incidents occurring as a result of poor communications between staff at shift change or during maintenance or other engineering work. • safe shutdown procedures should be in place. • communication channels with emergency services and other relevant authorities should be established, and available for use in the event of an incident. Procedures should include the assessment of harm following an incident and the steps needed to redress this • appropriate control techniques should be in place to limit the consequences of an accident, such as; fire walls, fire breaks isolation of drains, provision of oil spillage equipment, alerting of relevant authorities and evacuation procedures. • personnel training requirements should be identified and training provided. • the systems for the prevention of fugitive emissions are generally relevant and in addition, for drainage systems: – procedures should be in place to ensure that the composition of the contents of a bund sump, or sump connected to a drainage system, are checked before treatment or disposal; – drainage sumps should be equipped with a high-level alarm or with a sensor and automatic pump to storage (not to discharge); – there should be a system in place to ensure that sump levels are kept to a minimum at all times; – high-level alarms and similar back-up instruments should not be used as the primary method of level control. • duplicate or standby plant should be provided where necessary, with maintenance and testing to the same standards as the main plant; • spill contingency procedures should be in place to minimise accidental release of raw materials, products and waste materials and then to prevent their entry into water. • process waters, potentially contaminated site drainage waters, emergency firewater, chemically-contaminated waters and spillages of chemicals should be contained and, where necessary, routed to the effluent system and treated before emission to controlled waters or sewer. Sufficient storage should be provided to ensure that this can be achieved. Any emergency firewater collection system should take account of the additional firewater flows and fire-fighting foams, and emergency storage lagoons may be needed to prevent contaminated firewater reaching controlled waters (see the Releases to water references). • consideration should be given to the possibility of containment or abatement of accidental emissions from vents and safety relief valves/bursting discs. Where this may be inadvisable on safety grounds, attention should be focused on reducing the probability of the emission. • spillage prevention controls must be in place during the transfer of substances (for example, transfer of bulk liquid waste from tanker to storage vessels). – The weakest link and subsequently the main source of spillage during transfer from the vehicle to storage arises from the transfer hoses. This is due to either: – “tanker drive-off” - a vehicle pulling away whilst still coupled (systems should be in place

Indicative BAT requirements for accidents and abnormal operation
to prevent this) **– or because the hose couplings have become damaged or are incompatible. Although the spillages tend to be relatively small, measures should be taken to ensure that the couplings are the correct fit and system. This will prevent the coupling loosening or becoming detached, and in turn will also be helped by the facility providing and maintaining its own hoses.** **– A more serious event would occur if the coupling were unable to withstand the maximum shut valve pressure of the transfer pump.** **– Spillages of this nature may also be a source of odour and represent poor “housekeeping” practice, requiring constant attention and cleaning.** **– Protection of the transfer hose may not be necessary where a gravity feed system is in place. It will however still be important to maintain a sound coupling at each end of the transfer hose.** **– A more acute accident situation may arise due to the failure of plant or equipment. This may include the failure of a pump seal or the blockage of a filter pot commonly used at transfer points. The prevention of these situations should be addressed by the provision of routine maintenance.** **Accumulations of liquids in bunds, sumps, etc, should be dealt with promptly**

10 Monitoring

This section describes monitoring and reporting requirements for emissions to all environmental media. Guidance is provided for selecting the appropriate monitoring methodologies, frequency of monitoring, compliance-assessment criteria and environmental monitoring.

Process monitoring is dealt with elsewhere.

10.1 Environmental monitoring

10.1.1 Indicative BAT requirements for environmental monitoring

Indicative BAT requirements for environmental monitoring
1 The Operator should consider the need for environmental monitoring to assess the effects of emissions to controlled water, groundwater, air or land, or emissions of noise or odour. **2 Environmental monitoring may be required, for example, when:** **• there are vulnerable receptors** **• the emissions are a significant contributor to an Environmental Quality Standard (EQS) that may be at risk** **• the Operator is looking for departures from standards based on lack of effect on the environment;** **• to validate modelling work.** **3 The need should be considered for:** **• groundwater, where it should be designed to characterise both quality and flow and take into account short- and long-term variations in both. Monitoring will need to take place both up gradient and down-gradient of the site** **• surface water, where consideration will be needed for sampling, analysis and reporting for upstream and downstream quality of the controlled water** **• air, including odour** **• land contamination, soils, including vegetation, and agricultural products** **• assessment of health impacts** **• noise** **4 Where environmental monitoring is needed, the following should be considered in drawing up proposals:** **• determinands to be monitored, standard reference methods, sampling protocols** **• monitoring strategy, selection of monitoring points, optimisation of monitoring approach** **• determination of background levels contributed by other sources** **• uncertainty for the employed methodologies and the resultant overall uncertainty of measurement**

Indicative BAT requirements for environmental monitoring
• quality assurance (QA) and quality control (QC) protocols, equipment calibration and maintenance, sample storage and chain of custody/audit trail
• reporting procedures, data storage, interpretation and review of results, reporting format for the provision of information for the Regulation
<u>Monitoring of emissions to air:</u>
5 daily olfactory odour monitoring programmes should be in place.
<u>Monitoring of emissions to land:</u>
6 There should be no emissions to land and consequently there are no monitoring requirements.
<u>Monitoring of emissions to groundwater:</u>
7 Groundwater monitoring should take place where:
• there are any subsurface structures carrying or holding waste or other harmful substances for example, fuel
• there is uncertainty about surfaces on operational areas and drainage systems, especially on older sites

10.1.2 The Environment Agency's Monitoring Certification Scheme (MCERTS)- Background

The Environment Agency has established its Monitoring Certification Scheme (MCERTS) to deliver quality environmental measurements. MCERTS provides for the product certification of monitoring systems (for example, instruments, analysers and equipment), the competency certification of personnel and the accreditation of laboratories under the requirements of European and International standards. MCERTS has been developed to reflect the growing requirements for regulatory monitoring to meet European and International standards. It aims to get the relevant standards into a scheme that can be easily accessed by key stakeholders, such as manufacturers, operators, regulators and test houses.

MCERTS will be extended to include all regulatory monitoring activities. Technical Guidance Notes M1 and M2 are key reference documents underpinning MCERTS for stack-emission monitoring. The Environment Agency has published MCERTS performance standards for continuous emissions monitoring systems (CEMs), ambient air quality monitoring systems (CAMs), the chemical testing of soils, water monitoring instrumentation and manual stack emissions monitoring. Other MCERTS standards are under development to cover portable emissions monitoring equipment, data acquisition and operators' own arrangements, calibration and maintenance of monitoring equipment. Organisations undertaking manual stack emission monitoring (and any subsequent analysis of samples) must be accredited by UKAS to ISO/IEC 17025.

Further information about MCERTS is provided on our website (see links in Appendix 12.4).

A revised bioaerosol monitoring protocol will be published in early 2014.

11 Impact

11.1 Impact assessment

You will need to assess the risks to the environment and human health when applying for a bespoke permit under the Environmental Permitting Regulations 2010. The H1 Environmental Risk Assessment framework consists of an overview guide and a set of supporting technical annexes for specific risks (See link in Appendix 12.4)

11.2 Habitats

The EU Habitats Directive aims to protect the wild plants, animals and habitats that make up our diverse natural environment.

The directive created a network of protected areas around the European Union of national and international importance. They are called Natura 2000 sites. These sites include:

- Special Areas of Conservation (SACs) - these support rare, endangered or vulnerable natural habitats, plants and animals (other than birds).

- Special Protection Areas (SPAs) - these support significant numbers of wild birds and their habitats.

In the UK, the Habitats Directive is implemented by the Conservation of Habitats and Species Regulations 2010, more commonly known as the Habitats Regulations.

If you apply for any bespoke environmental permit, we must consider its potential impact on these important protected sites.

We strongly advise you to have a pre-application discussion with us before preparing and submitting an application so that we can let you know if any protected sites might be affected.

Refer to Appendix 12.4 for a link to further information.

12 Appendix

12.1 Appendix 1: Feedstock Properties and suggested EWC Codes

Types of Waste	EWC Code	Typical Moisture Content	Typical C:N ratio
Crop residues and fruit/vegetable processing wastes			
Apple filter cake	02 03 04	60	13
Apple pomace	02 03 04	88	48
Apple processing sludge	02 03 04	59	7
Cocoa shells	02 03 04	8	22
Coffee grounds	02 03 04		20
Corn cobs (Average)	02 03 04	15	98
Corn stalks	02 03 04	12	60-73
Fruit wastes	02 03 04	62-88	20-49
Olive Husks	02 03 04	8-10	30-35
Potato processing sludge	02 03 04	75	28
Soybean meal	02 03 04		4-6
Tomato processing waste	02 03 04	62	11
Beet leaves	02 03 04		15
Vegetable produce	02 03 04	87	19
Vegetable wastes	02 03 04		11-13
Fish and meat processing			
Blood wastes (slaughterhouse waste and dried blood)	02 02 02	10-78	3-3.5
Crab and lobster wastes	02 02 02	35-61	4.0-5.4
Fish breading crumbs	02 02 02	10	28
Fish processing sludge	02 02 02	94	5.2
Fish wastes (gurry, racks)	02 02 02	50-81	2.6 -5.0
Mixed slaughterhouse waste	02 02 02		2.0 – 4.0
Mussel wastes	02 02 02	63	2.2
Poultry carcasses	02 02 02	65	5
Manures			
Paunch manure (partially digested ruminant feed taken from the rumens of slaughtered cattle)	02 01 06	80-85	20-30
Shrimp wastes	02 01 06	78	3.4
Broiler litter (poultry litter)	02 01 06	22-46	12-15
Cattle manure	02 01 06	11-30	67-87
Horse manure general	02 01 06	59-79	22-50
Horse – race track manure	02 01 06	52-67	3-10
Sheep manure	02 01 06	60-75	13-20
Swine manure	02 01 06	65-91	9-19
Turkey litter	02 01 06	26	16
MSW			

Food waste	20 01 08		
Paper from sorted domestic refuse	20 01 01	18-20	127-178
Sewage sludge (activated)	20 03 06		6
Sewage sludge (digested)	20 03 06		16
Straw, hay silage			
Corn silage	02 01 03	65-68	38-43
Hay – general	02 01 03	8-10	15-32
Hay - legume	02 01 03		15-19
Hay – non legume	02 01 03		32
Straw – general	02 01 03	4-27	48-150
Straw – oat	02 01 03		48-98
Straw - wheat	02 01 03		100-150
Wood and paper			
Bark – hardwoods	03 03 01		116-436
Bark – softwoods	03 03 01		131-1,285
Corrugated cardboard	15 01 01	8	563
Sawmill waste	03 01 05		170
Newsprint	20 01 01	3-8	398-852
Paper fibre sludge	03 03 01	66	250
Paper mill sludge	03 03 01	81	54
Paper pulp	03 03 01	82	90
Sawdust	03 01 05	19-65	200-750
Telephone books	20 01 01	6	772
Hardwood chips/shavings	03 03 01		451-891
Softwood chips/shavings	03 03 01		212-1,313
Garden wastes and other vegetation			
Grass cuttings	20 02 01		9-25
Leaves	20 02 01	38	40-80
Seaweed	20 02 01	53	5-27
Shrub trimmings	20 02 01	15	53
Tree trimmings	20 02 01	70	16

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Condition or Situation	Potential Problem	Indicators	Recommendations
Temperatures			
Pile fails to heat	Materials may be too dry	Should be able to squeeze barely a drop of moisture from handful of compost taken from within the pile (squeeze test for moisture content - see* below)	Add an appropriate quantity of water or wet ingredients either at feedstock preparation or in processing. IVC waste will be amended on transfer from vessels.
	Materials may be too wet	Materials look or feel soggy; pile slumps; moisture content greater than 60%	Add dry amendments and remix and/or mix or aerate (during dry weather conditions if outdoors) to drive off some moisture by evaporation. Outdoor material: form batches with apex-shaped top to maximise rain run-off.
	Not enough nitrogen, or materials are degrading too slowly or are too stable	C:N greater than 50:1, large amount of woody materials	Add nitrogen rich ingredients and reassess composting recipe/ source feedstock. Ingredients must provide a nitrogen source that is freely available
	Cold weather and small pile size	Pile height less than 1m	Consider enlarging or combining piles; covering piles or adding highly degradable ingredients. If enlarging or combining piles, account should be taken of the particle size i.e. if the particle size is small, the enlarged windrow size should not be as large as if particle size were large because the higher the windrow the greater the compaction in the basal layer and the lower the airflow.
	pH excessively low	pH measures less than 5.5; refuse like odour	Add lime or wood ash and remix.
Temperature falls consistently over several days (during sanitisation phase or early period in stabilisation phase)	Low oxygen, poor aeration	Temperature declines gradually rather than sharply	Turn or aerate pile
	Excessive ventilation leading to cooling of aerated piles	Temperatures recover when aeration is switched off	Reduce aeration rate.
	Low moisture	Cannot squeeze water from material	Add water
Uneven temperatures (large differences rather than small ones)	Poorly mixed materials	Visible differences in the pile moisture and materials	Turn or remix pile
	Uneven airflow or air short circuiting, in the case of forced aeration.	Visible differences in the pile moisture and materials	Shorten aeration pipe - ratio of shortest to longest air path to the surface less than 1:1.5; remix materials
	Materials at different stages of biodegradation	Temperature varies along the pile length. There will be ABPR non-compliance if cross contamination between raw and sanitised material has occurred, in which case corrective action is required.	Resanitise the entire composting batch if material is subject to ABP regulations and cross-contamination of the type described has occurred.

Gradually falling temperatures and pile does not reheat after turning or aeration	Composting nearing completion (very low rate biodegradation)	Approaching expected composting time period; adequate moisture available; C:N less than 20:1, contains more nitrate than ammonium	None required
	Low moisture	Cannot squeeze moisture from materials	Add water and remix; Target moisture levels between 50% to 70% (wet basis)
Pile overheating (temperature greater than 70°C)	Insufficient aeration for heat removal	Pile is too moist	Turn pile or increase the airflow rate consider dry amendment material.
	Moderate to low moisture; limited evaporative cooling	Pile feels damp but not excessively wet or dry	Add water; continue turning and aerating to control temperature
	Pile is too large	Height greater than 2.5-3 m	Decrease the pile size
Pile too hot and then stops heating	Thermal kill has occurred	Temperature peaks and then begins to drop	Remix pile Turn pile and monitor manage before 70 ^{o}C occurs
Extremely high temperatures (>80 °C) in pile; composting or curing/storage	Pyrolysis or spontaneous combustion	Low moisture content; pile interior looks or smells charred	Caution when digging into material as exposure to air may cause ignition. Decrease pile size; adjust and maintain optimal moisture content;. Initiate fire action plan. Spread out and douse with water in areas that are charred or smouldering sections; breakdown pile. Alert fire service.
High temperatures or odours in curing or storage pile	Compost is not stable	Short active composting period; temperature and odour change after mixing	Manage pile for temperature, moisture and odour control, turn piles as necessary; limit pile size. Reprocess on permitted area. Monitor for leachate breakout
	Piles are too large	Height greater than 2.5m; width greater than 6m	Decrease pile size
<u>Odour Issues</u>			
Ammonia odour coming from composting piles	High nitrogen level	C:N less than 20:1	Add high carbon feedstock supplement
	High pH	pH greater than 8	Lower pH with acidic ingredients and/or avoid alkaline ingredients
	Carbon not readily available	Large woody particles have C:N greater than 30:1 but C:N of entire composting mixture is less than 30:1	Use additional carbon supplement, increase the carbon proportion of the existing feedstock using a material that releases carbon more readily, or shred carbon-rich woody material to a smaller size (increases surface area

			: volume therefore increasing readily available carbon).
Rotten eggs or putrid odours coming from composting piles continually	Anaerobic conditions: Low temperatures		
	Materials too wet (generally greater than 70 % m/m fresh matter)	Add dry feedstock supplement material to reduce moisture	
		Physical treatment such as shredding to increase surface area	
	Poor structure	Add bulking agent e.g. woodchip or other woody materials to improve structure and porosity.	
	Pile compacted	Remix pile and add bulking agent if necessary	
	Insufficient aeration	Turn pile to increase the airflow rate	
	Anaerobic conditions: High temperatures		
	Pile too large	Decrease the pile size	
	Airflow uneven or short circuiting	Remix pile; change recipe	
Odours generated only after turning	Odorous raw material	Appears more severe at high temperatures	Frequent turning; increase porosity through incorporation of a bulking agent e.g. woodchips; add odour absorbing amendment
	Insufficient aeration; anaerobic interior	Falling temperatures	Shorten time interval between turnings; increase porosity through incorporation of a bulking agent e.g. woodchips
Site-related odours (composting piles not odorous)	Raw materials	Odour is characteristic of the raw material	Reject raw materials if appropriate. Work with suppliers to eliminate substantial decay of feedstock prior to delivery
			Potential blending of feedstocks with materials that adsorb odour such as finished compost product or shredded woody oversize material
			Handle raw materials promptly with minimal storage
			Enclosed stockpiling of feedstock with air management system
			Practice good housekeeping, remove materials from equipment, instigate routine cleaning schedules
	Leachate puddles because of poor drainage	Standing puddles of water; ruts in pad	Divert runoff away; maintain hard surfaces and pavements

Site-related odours (composting piles not odorous)	Holding pond or lagoon overloaded with nutrients or sediment	Heavy algae and weed growth; gas bubbles on pond surface	Install sediment traps; enlarge pond surface area; use runoff and pond water in the early processing as pathogens may have been present in the pond / lagoon water. Aerate lagoons or cover with inert pumice filter material.
	Shredding and turning of composting materials		Enclosed area for shredding. Minimise shredding and turning of composting materials when prevailing wind is in the direction of (nearest) sensitive receptors.
Persistent odour issues	Odour not mitigated by process optimisation and feedstock amendment	Add on-site abatement plant such as a biofilter	
		Re circulating water within scrubbers has become saturated and needs replacing. Check blow down traps and clean and recharge.	
Pests			
Fly problems	Flies breeding in composting piles	Fresh manure or food material at pile surface; flies hover around piles	Turn piles every four to seven days to turn fly eggs and maggots into hot interior; cover static piles with a six inch layer of compost or a gas-permeable cover.
	Flies breeding in raw materials	Wet raw materials stored on site for more than four days	Handle raw materials promptly. Reduce surface area of storage. Use contained storage bins.
	Mosquitoes breeding in stagnant water	Standing puddles of water; nutrient-rich pond or lagoon	Grade site properly; maintain pad surface; maintain holding pond or lagoon in aerobic condition
Animal infestation - rodents, birds	Potential contravention of the Animal By-Products Regulations and Environmental Protection Act 1990.	Food scraps exposed, animal access evident e.g. rodent droppings, bird droppings. Damage to building fabric indicating pest entry, burrows in banks and compost stockpiles due to incomplete processing of material.	Process as soon as possible
			Improve housekeeping, clean up spills. Secure food waste storage. Sealed bins are better than open floor storage.
			Eliminate potential areas of harbourage. Turn over the feedstock and mature compost stockpiles frequently. Reprocess material.
			Enclose spaces with netting to prevent birds gaining access.
			Initial pest control plan and employ contracted exterminators/ pest control

Compost			
Compost contains clumps of materials and large particles; texture is not uniform	Poor mixing of materials or insufficient turning	Original raw materials discernible in compost	Screen compost; improve initial mixing
		Wet clumps of compost incomplete processing	Remix and reblend material may require further processing on permitted area to active complete composting.
	Raw materials contain large particles and non-degradable or slowly degradable materials	Large amounts of contraries, particles in compost, such as stones, plastic or rocks in compost	Improve waste acceptance and reject policy. Screen and wind sifting may be required. Consider contingency for disposal if material is too contaminated for end use.
	Actively managed composting phases not completed by compost batch being assessed	Curing/maturation or storage piles heat significantly or release odours	Lengthen composting time and/or improve composting conditions

12.2 Appendix 2 Trouble shooting guidance.

12.3 Appendix 3: System Advantages and Disadvantages

Technology	Advantages	Disadvantages
Windrow Composting	Established process internationally. Management practises are well established Aside from Shredders, Specialist equipment is not necessary. Operations can be largely covered by Standard Rules Permits. Troubleshooting information is widely available. Maintenance requirements are largely limited to paving and mobile plant. Possible to produce high quality material for horticulture and agriculture markets with non-waste status Reduced capital costs for start-up when compared with IVC. Versatile technology which can produce high quality outputs when managed correctly.	Requires significant land area to accommodate windrow piles during active composting phase and subsequent maturation. Weather issues can affect moisture, increase leachate generated and makes moisture porosity and temperature control difficult, any of which can result in product quality issues. On larger sites it can be difficult to control odour and bio-aerosol emissions during turning operations, if windrow is located outside. Proximity to sensitive receptors is an issue, especially during shredding, turning and screening operations. A distance of at least 250m from sensitive receptors is required for a standard permit. May require downtime, i.e. no deliveries of feedstock, whilst critical equipment such as shredders are being maintained. Contingency needs to be planned. ABPR waste cannot be processed solely by this method. When anaerobic condition develops it is difficult to correct and may cause high incidence of odour. Limited feedstocks. May require downtime whilst critical equipment such as shredders are being maintained.
Aerated Static Pile	Requires minimal turning, Negative aeration may reduce the potential for bio-aerosol and odour release. If negative air pressure is adopted then process air can be collected and treated through a managed biofilter. More control of process as aeration is typically controlled by either a timer or on feedback from a temperature sensor. Can achieve faster composting than windrow composting. Requires less physical maintenance of waste once piles are built. Standard Rules Permit for throughputs up to 75kte IED will apply in sites that take > 25 kte Lower operating costs than using a loading shovel or self-propelled turner as the fuel costs (electricity) is minimal compared to the cost of Diesel.	Negative aeration systems can become clogged which can result in uneven composting. Additional filter/bedding material may need to be provided, i.e. woodchips. Good housekeeping is essential with regular cleaning regime. Best practice would be to clean pipe work after each dismantling. Maintenance of equipment required to stop pipe blockages etc. May require downtime, i.e. no deliveries of feedstock, whilst critical equipment such as shredders and fans are being maintained. Risk of fires May require downtime whilst critical equipment such as shredders are being maintained.
Continuous Block	Requires less land area than windrowing. Standard Permit for throughputs up to 75kte IED will apply in sites that take >25 kta Aside from a 360 loading shovel or side turner, does not require specialist turning equipment.	Not a commonly used composting method in the UK. May need more time to treat waste. System is not compliant with ABPR as no separation of the material for sanitisation Too large to be housed.

Technology	Advantages	Disadvantages
	Maintenance requirements are largely limited to mobile plant, which can be hired if issues arise. Potential for greater throughput if managed effectively.	Open to the elements. Potential to generate leachate, odour and bioaerosols There are likely to be pockets of anaerobic material, however if the majority of the pile turns anaerobic then potentially a large operation to fix. Difficult to control in the event of fires May require downtime, i.e. no deliveries of feedstock, whilst critical equipment such as shredders are being maintained. May require downtime whilst critical equipment such as shredders are being maintained.
In-vessel Composting	Faster processing times than windrow composting if aeration and feedstock mix is managed Enclosed process which reduces potential for odour and bio-aerosol emissions, and allows the process gases to be controlled by an abatement system Closer process control, which can be automated, i.e. more even temperature and air distribution. Process requires less labour. Some containerised configurations are modular and can be increased in number as demand increases. Consistent quality of product, if process managed appropriately. Standard Rules Permit available for operations with throughputs up to 75kte IED will apply Some systems are modular which means maintenance can be undertaken whilst the site continues to accept feedstock deliveries.	Higher capital costs. Requires greater operator management control and a degree of skills and expertise Maintenance and depreciation of plant is costly If containment systems fail there can be issues with odour Operator must ensure contingency measures are in place to divert waste. May require downtime whilst critical equipment such as shredders are being maintained. May require back up generator in case of power outage. Focus is often just on the ABPR requirement and material is still very unstable. Second barrier if outside needs a high level of skilled management. May be restriction for land spreading Pathogen failures control will result in material being held on site and retreated-contingency to cope may be required.
Thermophillic Aerobic Digestion (TAD)	Technology is proven on sewage sludge treatment, albeit not widely adopted for food waste currently. Benefits will be largely inline with IVC. Standard Permit for throughputs up to 75kte. IED will apply. Digestate can be pelletised and used as a fuel in biomass boilers	Technology is used primarily in the UK to treat sewage sludge. Limited application with source segregated organic waste. Product quality issues are not known High temperatures in confined spaces can produce harmful off gases. Health and safety considerations will need to be taken into account. Operational issues are not documented for treating source segregated organic waste. High water consumption. May require downtime, i.e. no deliveries of feedstock, whilst critical equipment such as shredders, stirrers, pumps etc are being maintained/repaired.
Deep Clamp	Less area of land required Less turning required	Less control over process etc Not in common use, hence operational best practice is not well documented.

12.4 Appendix 4: Web Links List

Environmental Permitting Guidance “The Waste Framework Directive”

http://www.defra.gov.uk/publications/files/pb13569-wfd-guidance-091001.pdf.

Statute Law database

http://www.legislation.gov.uk/

Environment Agency - Environmental Permitting Guidance - “How to comply with your Environmental Permit”

http://www.environment-agency.gov.uk/business/topics/permitting/32320.aspx

Environment Agency - Environmental Permitting section

http://www.environment-agency.gov.uk/business/topics/permitting/default.aspx

Environment Agency – H1 Environmental Risk Assessment Guidance

http://www.environment-agency.gov.uk/business/topics/permitting/36414.aspx

Environment Agency – H5 – Site Condition Report Guidance

http://www.environment-agency.gov.uk/static/documents/Business/h5_scr_guidance_2099540.pdf

Environment Agency – H6 – Environmental Management Systems

http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/geho0410bshk-e-e.pdf

Environment Agency – Standard Permits

http://www.environment-agency.gov.uk/business/topics/permitting/32334.aspx

Environment Agency – Bespoke Permits

http://www.environment-agency.gov.uk/business/topics/permitting/117626.aspx

Environment Agency –Waste Exemptions

http://www.environment-agency.gov.uk/business/topics/permitting/32322.aspx

Environment Agency – Pollution Prevention

http://www.environment-agency.gov.uk/business/topics/pollution/32252.aspx

Environment Agency – Environmental Permitting Guidance

http://www.environment-agency.gov.uk/business/topics/permitting/32320.aspx

Environment Agency – Monitoring Emissions

http://www.environment-agency.gov.uk/business/regulation/31829.aspx

Environment Agency – Environmental Permitting Regulations: Operator Competence

http://www.environment-agency.gov.uk/static/documents/Business/RGN_5_Operator_Competence.pdf

Environment Agency – Managing invasive non-native plants

http://publications.environment-agency.gov.uk/PDF/GEHO0410BSBR-E-E.pdf

Environment Agency - Habitats and species protected under the Habitats Regulations quick guide

http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_7385_9a63bb.pdf

Environment Agency – Health Effects from Bioaerosols Position Statement

http://www.environment-agency.gov.uk/static/documents/Research/Composting__bioaerosols.pdf

Environment Agency - MCERTS Guidance

http://www.environment-agency.gov.uk/business/regulation/31829.aspx

WRAP – Food Waste Depackaging Equipment

http://www.wrap.org.uk/content/food-waste-depackaging-equipment

Defra - Animal health website

http://animalhealth.defra.gov.uk/

Information on SuDS provided by the construction industry research and information association (CIRIA)

http://www.susdrain.org

UK Planning and Building Regulations

www.planningportal.gov.uk

Organics Recycling Group – Standardised Protocol for Monitoring Bioaerosols

http://www.organics-recycling.org.uk/page.php?article=1750&name=Standardised+Protocol+for+Monitoring+Bioaerosols

HSE - Guidance for COSHH

http://www.hse.gov.uk/coshh/industry/engineering.htm

HSE - Guidance for COMAH

http://www.hse.gov.uk/comah/

13 Acknowledgements

The development of this guidance has not sought to provide new evidence but instead collate best industry practice.

In addition we would also like to acknowledge the technical input of our project team and the team at Jacobs and ADAS.

We also thanks ORG and their members for their input and comments which have been included where necessary in this guidance.

14 Glossary

Term	Definition
ABPR	Animal By-Product Regulations
Actinomycetes	A specific group of bacteria that is capable of forming very small spores. The most common organism in this group is responsible for causing a variety of infections
AD	Anaerobic Digestion
Aerobic	In the presence of air or oxygen
Aerosol	A suspension in gaseous medium of solid or liquid particles having a negligible falling velocity.
Anaerobic	Absence of oxygen.
Animal By-Products	These include animal carcasses, parts of animal carcasses (including blood) or products of animal origin not intended for human consumption, with the exception of animal excreta and catering waste.
Aspergillus fumigatus	Species of fungus with spores that can cause allergic reactions in some people.
Bacteria	A group of micro-organisms with a primitive cellular structure, in which the genetic material is not retained within an internal membrane (nucleus).
Bioaerosols	Micro-organisms suspended in air.
Bio-fertiliser	Digestate derived from source segregated organic material and which and can be added to soil/ applied to land to improve the nutrient value.
Biofilter	Organic, microbially active substrates (the medium) that filter odorous air through the action of micro-organisms that grows on the medium.
Biowaste	Organic waste material
BMW	Biodegradable Municipal Waste
Bulking agent	Material added to improve the structure of a feedstock material e.g. woodchips.
Carbon to nitrogen ratio (C:N)	The ratio of total organic carbon to total nitrogen.
CGAP	Good Agricultural Practice
CH_4	Methane
CHP	Combined Heat and Power
COD	Chemical Oxygen Demand
COMAH	Control of major accident hazards
COSHH	Control of Substances and Hazardous to Health (1994)
CQP	Compost Quality Protocol
Digestate	Fully treated stabilised, sanitised product from Anaerobic Digestion
EA	Environment Agency
EDPM	Ethylene Propylene Diene Monomer
EP	Environmental Permitting
FIFO	First In, First Out
FW	Food Waste
FYM	Farmyard Manure
GC	Gas Chromatograph
GHG	Green House Gas
Green waste	Organic garden waste such as grass clippings, tree prunings, leaves etc, which can be used as composting feedstock. Synonymous with ‘garden wastes’, ‘yard trimmings’, ‘botanical wastes’, or ‘garden trimmings’. They can arise from domestic gardens, public areas, private parks or gardens, or landscaping activities.

Term	Definition
GWP	Global Warming Potential
HACCP	Hazard and Critical Control Points
HDPE	High Density Poly Ethylene
Hazop	Hazard and operability study
HSE	Health and Safety Executive
Impermeable paving	a surface or pavement constructed and maintained to a standard sufficient to prevent the transmission of liquids beyond the pavement surface.
kW	kilowatt (1 kW = 103 W)
kWe	Kilowatt electrical (refers to electric power produced)
kWh	Kilowatt hour
kWt	Kilowatt thermal (refers to thermal power produced)
Leachate	Liquid run-off from stored feedstocks or outputs that contains dissolved substances or suspended solids from that material.
LPA	Local Planning Authority
MBT	Mechanical Biological Treatment
Mesophilic	Group of microorganisms that operate around 35^{o}C
Micro-organisms	Microscopic organisms that are capable of living on their own. Often simply called ‘microbes’.
Moisture content	The mass of water in a sample, usually expressed as a percentage on a mass for mass basis (m/m).
MSW	Municipal Solid Waste
MW	Megawatt (1 MW = 103 kW)
MWe	Megawatt electrical (refers to electric power produced)
MWh	Megawatt hour
MWt	Megawatt thermal (refers to thermal power produced)
NPK	Nitrogen, Phosphorous and Potassium
NVZ	Nitrate Vulnerable Zone
Odour	A chemical or mixture which stimulates a human olfactory system so that an odour is perceived. In the context of this guide, odours are generally presumed to be unwanted, unpleasant or malodorous, unless otherwise indicated.
OFMSW	Organic fraction of municipal solid waste
Organic matter	A collection of complex humic substances and other organic compounds, generally of animal or vegetable origin.
Organic waste	A general, loosely defined term used to describe materials derived from long living organisms that can be composted.
Pathogen	A micro-organism with the potential to cause disease through infection.
Pathogen kill	Reflects the temperature or and residence time it takes to kill harmful soil and plant pathogens.
pH (potential Hydrogen)	The measure of acidity/alkalinity (as in soils, composts, solutions, etc.) It is a logarithmic scale. pH 7 is neutral. Not to be confused with total acidity or alkalinity.
pKa	A measure of the acid dissociation.
PTE	Potentially toxic element
RDF	Refuse Derived Fuel
TAD	Thermophilic Aerobic Digestion
Sanitisation	The destruction of pathogenic micro-organisms, weed seeds and weed propagules by exposure to high temperatures (above 55oC) over an extended period of time.
SCADA	Supervisory and Control Data Acquisition system
Self-heating	The rise in temperature during composting, caused by the metabolic activity of

Term	Definition
	microbes.
Soil conditioner	A soil additive that improves its structural and textural qualities reducing its susceptibility to degradation
Structural material	Material able to resist settling and compaction
TAN	Total Ammonia Nitrogen
Thermophilic	Group of microorganisms that operate around 55^{o}C
TK	Total Potassium
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TS	Total solids (% of wet weight)
TS	Total Solids
VS	Volatile solids (% of total solids or % of wet weight)
WAS	Waste activated sludge
WWTP	Wastewater treatment plant

Composting and potential health effects from bioaerosols: guidance for permit applicants

This guidance applies to any environmental permit application for a new waste treatment facility that would include composting activities located within 250 metres of the 'nearest sensitive receptor' (typically dwellings or workplaces). It may also apply, under similar circumstances, where an operator applies to vary their existing permit. It applies to both waste operations permits and installations permits.

It updates and replaces our 2010 position statement.

Background

We can only grant permits where the applicant is able to satisfy us that the permitted activities will not pose an unacceptable level of risk to nearby 'sensitive receptors'. Commercial-scale composting activities can produce potentially harmful bioaerosols, which pose a risk to those living or working nearby. The degree of risk will depend on the location of the composting facility, the techniques and infrastructure it will use, and the way it will be managed. This guidance advises applicants on the approach we will take in determining permits for composting facilities, taking into account bioaerosol risks. It should therefore help applicants and developers to screen out unsuitable proposals, put together good applications and streamline the permitting process.

Applications for new facilities

If the proposed composting activities are at least 250 metres from the nearest sensitive receptor we will not normally require an applicant to carry out a bioaerosol risk assessment before granting them a permit and the permit we issue will not normally include any bioaerosol monitoring requirements.

If the proposed composting activities are within 250 metres of the nearest sensitive receptor we will normally only grant a permit in cases where, either

a. the scale of the proposed composting activities is such that no more than 500 tonne of waste would be handled at any one time and the applicant has provided us with a suitable site-specific bioaerosol risk assessment (SSBRA) in support of their application, or

b. more than 500 tonne of waste would be handled at any one time, but the composting activities would be carried out in a way and with the necessary infrastructure (e.g. negative aeration, enclosure) such that they are not likely to result in the uncontrolled release of high levels of bioaerosols, and the applicant has provided us with a suitable SSBRA in support of their application.

A suitable SSBRA is one that satisfies us that the proposed activities would be unlikely to expose the nearest sensitive receptor to elevated concentrations of bioaerosols from the composting activities for prolonged periods.

In other cases, for example if an applicant is applying for a permit for a new, large-scale open-windrow composting facility located within 250 metres of the nearest sensitive receptor, we will advise applicants that they will need to revise their proposals before we could grant them a permit.

We will assess the need for monitoring at new sites within 250 metres of sensitive receptors as part of the permit determination, based on the individual circumstances of the particular site and taking into account the cost of monitoring.

Permit variation applications

Similar considerations may apply to permit variations, depending on the scale and nature of the proposed variation.

Definitions

composting activities - Composting is the biological decomposition of biodegradable waste under conditions that are predominantly aerobic and that allow the development of thermophilic temperatures as a result of biologically produced heat Composting activities include any associated waste storage and treatment activities.

nearest sensitive receptor means the nearest place to the composting activities where people are likely to be for prolonged periods. This term would therefore apply to dwellings (including any associated gardens) and to many types of workplaces. We would not normally regard a place where people are likely to be present for less than 6 hours at one time as being a sensitive receptor. The term does not apply to those controlling the composting facilities, their staff when they are at work or to visitors to the facility, as their health is covered by Health and Safety at Work legislation, but would apply to dwellings occupied by the family of those controlling the composting facility.

elevated concentrations of bioaerosols from the composting operations refers to the concentrations of bioaerosols (as predicted or as derived from direct measurements) at the sensitive receptors, which are attributable to the composting operations. In the case of direct measurements at a location downwind of a composting activity, the attributable concentration is derived from the downwind concentration minus the concentration upwind of the activity. We would regard concentration of over 300, 1000 and 500 cfu m^{-3}, for gram-negative bacteria, total bacteria and *Aspergillus fumigatus* respectively, as being elevated.

handled at any one time refers to the total quantity of waste being stored or treated at any one time.

activities…likely to result in the uncontrolled release of high levels of bioaerosols include the shredding of waste and the turning of waste during the composting process where these operations are not contained or are not subjected to exhaust ventilation and scrubbing/filtering.

Further advice

Further advice on dealing with waste can be found on our website or by calling our customer service team on 08708 506 506

Version 2.0

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Explanatory note

Bioaerosols, composting and health effects

Bioaerosols are complex mixtures of airborne micro-organisms and their products, and are ubiquitous, particularly in rural environments. The most serious health problems appear to arise from *Aspergillus fumigatus,* but there are other fungal spores and bacteria that cause problems. International studies have shown that there is a wide variability in individual susceptibility to bioaerosol exposure.

Commercial-scale composting activities tend to generate large amounts of bioaerosols and these are likely to contain human allergens and pathogens. They have potential effects on respiratory health and may cause headaches, nausea and fatigue. There has been very little investigation into the effects of community exposure to bioaerosols from composting, but there is some limited data that suggest that living close to a composting facility may be associated with an increased risk of adverse health effects. The consensus from various studies is that bioaerosols from composting activities decline rapidly within the first 100 metres from a site and generally decline to background levels within 250m.

The way we regulate composting facilities

Many small scale composting facilities will be able to operate without the need for an environmental permit. They just have to be registered with us as exempt waste operations. Larger scale facilities will need to operate under an environmental permit issued by us. This will either be a bespoke permit or a standard rules permit. Standard rules permits are available for composting facilities which are to be located more than 250 metres from the nearest sensitive receptor.

About the SSBRA

Generally, the complexity of a risk assessment is related to the size and complexity of the proposed facility and the uncertainty of the risk posed, varying from a qualitative, largely generic approach at one extreme to a site specific quantitative risk assessment at the other. With respect to bioaerosol risks, we consider that a qualitative SSBRA will normally be adequate for a new composting facility within 250 metres of the nearest sensitive receptor, provided that the facility will either:

a. handle no more than 500 tonne waste at any one time, or

b. handle more than this, but carry out operations in a way and with the necessary infrastructure (e.g. negative aeration, enclosure) such that they are not likely to result in the uncontrolled release of high levels of bioaerosols

Standard methods of determining bioaerosol levels are available. However, based on our present scientific understanding of bioaerosols, the way they behave and their health impacts, we now consider that there is currently no suitable methodology for carrying out adequate **quantitative** SSBRAs for new composting facilities. Accordingly, we believe that we need to take a precautionary approach and not normally permit those facilities where we would have expected a quantitative, rather than a qualitative, SSBRA until such time as a suitable methodology becomes available.

The types of new facilities affected by this are those that would have both handled more than 500 tonnes of waste at any one time, and would have carried out any composting activities in the open that are likely to result in the uncontrolled release of high levels of bioaerosols. In practice, this would not include situations where the entire composting operation is carried out inside a building, or where composting takes place outside, but using negative aeration and without turning. However it would include compost maturation in conventional outdoor turned windrows carried out following other treatment operations such as in-vessel composting, treatment in a dry anaerobic digestion plant and treatment in a mechanical biological treatment plant.

Guidance on the evaluation of bioaerosol risk assessments for composting facilities is available on our website.