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Process Guidance Note 6/30(13)

Statutory guidance for mushroom substrate manufacturing processes and installations

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Defra would like to acknowledge the work of the Environment Agency's Local Authority Unit in the drafting of this guidance note.

Revision of the guidance

The electronic version of this publication is updated from time to time with new or amended guidance. **Table 0.1** is an index to the latest changes (minor amendments are generally not listed).

Table 0.1 - Revision of the guidance		

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1. Introduction

Legal basis

1.1 This note applies to the whole of the UK. It is issued by the Secretary of State, the Welsh Government, the Scottish Government and the Department of the Environment in Northern Ireland (DoE NI) to give guidance on the conditions appropriate for the control of emissions into the air from mushroom substrate manufacturing processes and installations. It is published only in electronic form and can be found on the Defra website. It supersedes PG6/30(06) and NIPG6/30(06).

1.2 This guidance document is compliant with the Code of Practice on Guidance on Regulation page 6 of which contains the "golden rules of good guidance". If you feel this guidance breaches the code or you notice any inaccuracies within the guidance, please contact us.

1.3 This is one of a series of statutory notes giving guidance on the Best Available Techniques (BAT). The notes are all aimed at providing a strong framework for consistent and transparent regulation of installations regulated under the statutory Local Air Pollution Prevention and Control (LAPPC) regime in England and Wales, Scotland and Northern Ireland. The note will be treated as one of the material considerations when determining any appeals against a decision made under this legislation. Further guidance on the meaning of BAT can be found for England and Wales, Scotland, and Northern Ireland.

1.4 In general terms, what are BAT for one installation in a sector are likely to be BAT for a comparable installation. Consistency is important where circumstances are the same. However, in each case it is, in practice, for regulators (subject to appeal) to decide what are BAT for each individual installation, taking into account variable factors such as the configuration, size and other individual characteristics of the installation, as well as the locality (e.g. proximity to particularly sensitive receptors).

1.5 The note also, where appropriate, gives details of any mandatory requirements affecting air emissions which are in force at the time of publication, such as those contained in Regulations or in Directions from the Government. In the case of this note, at the time of publication there were no such mandatory requirements.

1.6 In **Section 4** and **Section 5**, arrows are used to indicate the matters which should be considered for inclusion as standard permit conditions. It is important to note, however, that this should not be taken as a short cut for regulators to a proper determination of BAT or to disregard the explanatory material which accompanies the arrows. In individual cases it may be justified to:

- include additional conditions;
- include different conditions;
- not include conditions relating to some of the matters indicated.

In addition, conditions will need to be derived from other parts of the note, in particular to specify emission limits, compliance deadlines and mandatory requirements arising from directions or other legislation.

Who is the guidance for?

1.7 This guidance is for:

Regulators

- local authorities in England and Wales, who must have regard to the guidance when determining applications for permits and reviewing extant permits;
- the Scottish Environment Protection Agency (SEPA) in Scotland, and district councils or the Northern Ireland Environment Agency (NIEA), in Northern Ireland;

Operators who are best advised also to have regard to it when making applications and in the subsequent operation of their installation;

Members of the public who may be interested to know what the Government considers, in accordance with the legislation, amounts to appropriate conditions for controlling air emissions for the generality of installations in this particular industry sector.

Updating the guidance

1.8 The guidance is based on the state of knowledge and understanding, at the time of writing, of what constitute BAT for this sector. The note may be amended from time to time to keep up with developments in BAT, including improvements in techniques, changes to the economic parameters, and new understanding of environmental impacts and risks. The updated version will replace the previous version on the Defra website and will include an index to the amendments.

1.9 Reasonable steps will be taken to keep the guidance up-to-date to ensure that those who need to know about changes to the guidance are informed of any published revisions. However, because there can be rapid changes to matters referred to in the guidance – for example to legislation – it should not be assumed that the most recent version of this note reflects the very latest legal requirements; these requirements apply.

Consultation

1.10 This note has been produced in consultation with relevant trade bodies, representatives of regulators including members of the Industrial Pollution Liaison Committee and other potentially-interested organisations.

Policy and procedures

1.11 General guidance explaining LAPPC and setting out the policy and procedures is contained in separate documents for England and Wales, Scotland and Northern Ireland.

2. Timetable for compliance and reviews

Existing processes or activities

2.1 This note contains all the provisions from previous editions which have not been removed. Some have been amended. For installations in operation at the date this note is published, the regulator should have already issued or varied the permit having regard to the previous editions. If they have not done so, this should now be done.

2.2 The new provisions of this note and the dates by which compliance with these provisions is expected are listed in **Table 2.1**, together with the paragraph number where the provision is to be found. Compliance with the new provisions should normally be achieved by the dates shown. Permits should be varied as necessary, having regard to the changes and the timetable.

Table 2.1 - Compliance timetable

Guidance	Relevant paragraph/row in this note	Compliance date
Emission assessment and phased enclosure where offsite odour is persistent, recurrent and strong	Paragraph 4.8	Subject to the site specific permit

2.3 Replacement plant should normally be designed to meet the appropriate standards specified for new installations/activities.

2.4 Where provisions in the preceding guidance note have been deleted or relaxed, permits should be varied as necessary as soon as reasonably practicable. **Section 6** provides a summary of all changes.

2.5 For new activities, the permit should have regard to the full standards of this guidance from the first day of operation.

2.6 For substantially changed activities, the permit should normally have regard to the full standards of this guidance with respect to the parts of the activity that have been substantially changed and any part of the activity affected by the change, from the first day of operation.

Permit reviews

2.7 Under LAPPC, the legislation requires permits to be reviewed periodically but does not specify a frequency. It is considered for this sector that a frequency of once every eight years ought normally to be sufficient for the purposes of the appropriate Regulations. Further guidance on permit reviews is contained in the appropriate Guidance Manual for England and Wales chapter 26, Scotland, Practical guide section 10, Northern Ireland Part B Guidance page 9, Northern Ireland Part C Guidance chapter 17. Regulators should use any opportunities to determine the variations to permits necessitated by paragraph 2.2 above in conjunction with these reviews.

2.8 Conditions should also be reviewed where complaint is attributable to the operation of the process and is, in the opinion of the regulator, justified.

3. Activity description

Regulations

3.1 This note applies to LAPPC installations for mushroom substrate manufacture processes and installations. The activities for regulation are listed in **Table 3.1**.

Table 3.1 - Regulations listing activities

LAPPC	Activity	England and Wales	Scotland	Northern Ireland
		EPR Schedule 1 reference	PPC Schedule 1 reference	PPC Schedule 1 reference
Part B	Mushroom substrate production	Section 6.4 Part B	Section 6.4, Part B	n/a
Part C	Mushroom substrate production	n/a	n/a	Section 6.4 Part C

The links are to the original version of the Regulations. A consolidated version is not available on www.legislation.gov.uk

For England and Wales, an unofficial consolidated version is available but read the first page of that document in order to understand its status and content.

3.2 This note refers to mushroom substrate manufacturing processes. These are processes that blend straw with various additives including stable bedding, nitrogen sources (usually poultry manure) and other additives such as molasses, urea, sugars, activators, recycled water and agricultural gypsum prior to composting by thermophilic bacteria and subsequent pasteurisation for the production of substrate used for growing mushrooms.

3.3 The disposal of certain animal by-products fall under the controls of a European Regulation laying down health rules as regards animal by-products and derived products not intended for human consumption. Regulation (EC) 1069/2009), and the accompanying implementing Regulation (EC) 142/2011, applies from 4 March 2011 and repeals Regulation 1774/2002 (Animal by-products Regulation).

3.4 The Regulation specifies the permitted disposal methods for animal by-products, controls and records the movement of animal by- products and also details hygiene requirements in the collection, transport, storage and processing of animal by-products. Manure falls within these controls. Where there is any conflict between the standards of this note and the EU Regulation 1060/2009, the tighter standard should prevail because the Regulation is primarily concerned with the veterinary requirements of animal by-product disposal and for prevention of pathogens in animal feedstuffs.

Mushroom substrate industry

3.5 The industry producing mushroom substrate has sites which range considerably in size. Small sites are under 10,000 tonnes a year of Phase 1 product. Large sites are of the order of 100,000 tonnes.

Mushroom substrate production

3.6 The production of mushroom substrate can be separated into various stages. It should be noted that whilst the terms pre-wet and phase 1 have been used for convenience in describing these techniques, these distinctions are not universally applicable. Once the raw materials are brought together and wetted, microbiological fermentation proceeds along an indivisible course. Indeed, the early stages of composting can take place entirely in linear stacks, from bale breaking to filling of phase 1 tunnels.

Pre-wet processing

3.7 Any process for the production of mushroom substrate will begin with relatively dry raw materials. The aim of the pre-wet stage is to achieve an initial mixing of raw materials and the incorporation of moisture into the materials to begin the composting process. The basic raw material will be straw with various additives including stable bedding, nitrogen sources (usually poultry manure) and other additives such as molasses, urea, sugars, activators, recycled water and agricultural gypsum. There are various mechanical methods of mixing but the prime function of any mixing method is to achieve a homogeneous raw material base at the required moisture level.

3.8 Following initial mixing the materials will generally be stacked in the open, allowing a complex biological process to commence. The primary consideration in producing a mushroom substrate is the maintenance of a highly aerobic environment where high temperatures will be naturally generated. Further mixing may be required to achieve a higher degree of homogeneity (depending on the method in use). Aeration may be achieved by the mechanical movement of materials or by storage in bins or hoppers where forced ventilation is employed. All methods have the common aim of maintaining aerobic conditions throughout the mass of the substrate. For installations using movement to aerate, the materials should stand no longer than three days between each mixing if anaerobic conditions are to be avoided. Where forced ventilation is in use the need for further movement is limited to that required to provide a homogeneous mixture. During this phase additional moisture adjustment may be made using recycled process drainage effluent ('goody' water).

3.9 If correct conditions are maintained the resultant material will be evenly degraded and begin to turn dark brown. Anaerobic conditions will result in a lighter coloured "sour" smelling core to develop in the centre of the pile where composting is retarded by lack of oxygen which also leads to the generation of excessive odour.

Phase I composting

3.10 Following the achievement of a homogeneous, evenly degraded raw material base, the moisture content of the compost is adjusted and the compost is further degraded under more controlled conditions. Phase I composting is typically carried either in tunnels with forced aeration or in covered long stacks ('windrows') of approximately 1.8m wide by 2.0m high. During the phase I operation, the material undergoes composting by thermophilic bacteria and the compost mass will achieve temperatures of up to 75^{o}C. At the end of a successful phase I process the material should be soft, moist and evenly dark. Again anaerobic conditions will result in a lighter coloured material in the areas of the stack where composting is retarded.

3.11 In the case of the aerated tunnels, the oxygen content of the compost is monitored and aeration by underfloor vents or wall-mounted fans is controlled to maintain the oxygen content of the substrate typically between 3% and 12%. It is usual for the material to be turned once during the 7 days phase I operation to ensure thorough mixing and moisture control. In the case of the more traditional windrow methods the substrate is then normally mixed using mechanical compost turners at no more than 3-day intervals. This serves to replace depleted oxygen and allows further mixing to take place.

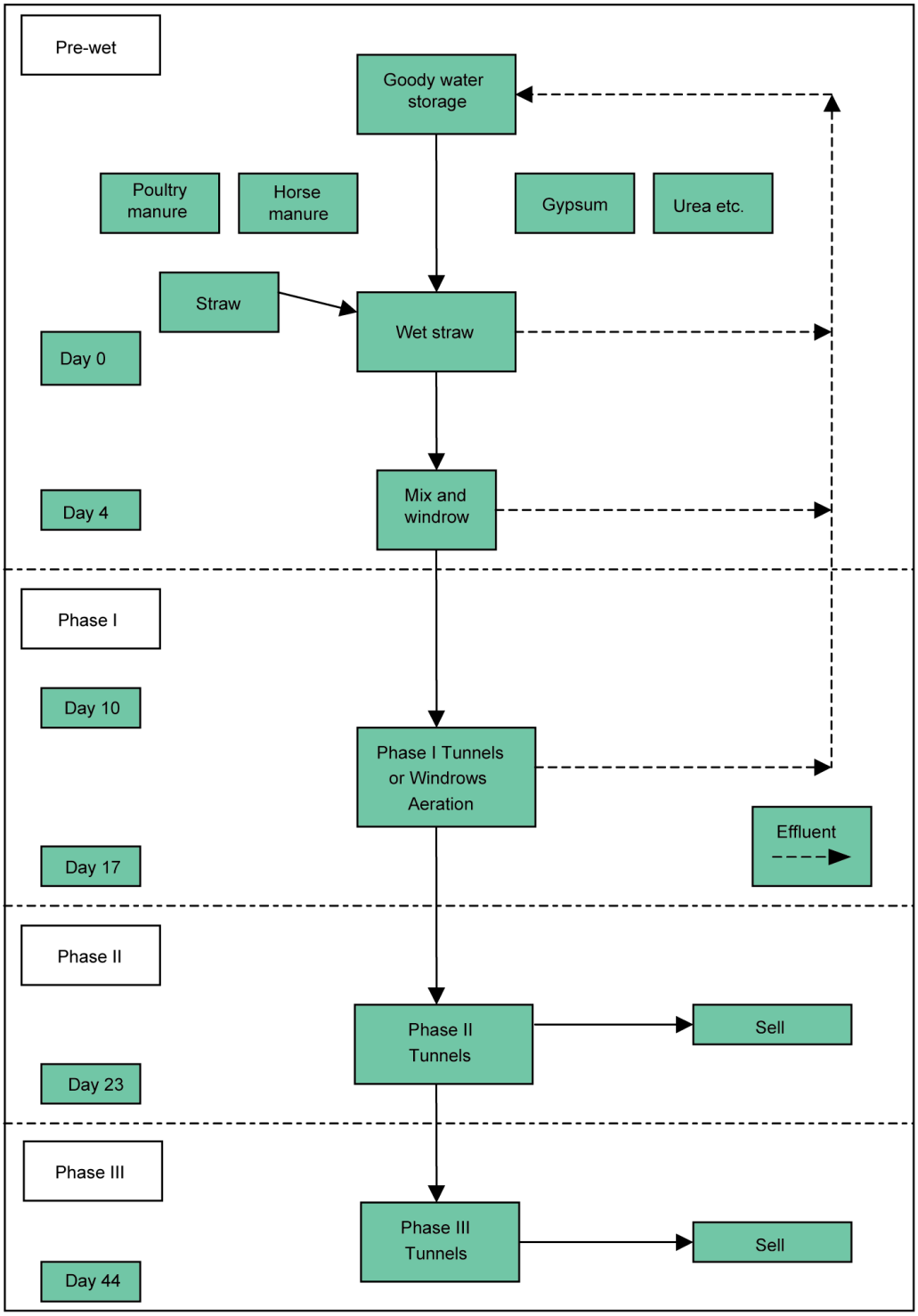
Phase II composting

3.12 By this point, the substrate has become a homogeneous mass and phase II composting is the final stage of preparation for the growing of mushrooms. It is always undertaken in closed rooms where environmental conditions can be manipulated to provide optimum conversion of various nitrogen sources into usable nutrients for the mushroom. The stage involves pasteurisation (substrate temperature 57-60°C) and a conditioning (substrate temperature 46-50°C). The whole of phase II is highly aerobic and as such generates little, if any, odour. At the end of phase II operations, mushroom spawn will be mixed and the substrate can be supplied to growers.

Phase III operations

3.13 There is a growing trend for the substrate manufacturer to carry out further processing of the material by allowing initial germination of the spawn in controlled conditions for a further 21 days. At this point the substrate must be introduced to growing bays within 24 hours. Again this phase does not generate any significant odour.

Figure 3.1 Typical flow diagram of mushroom substrate manufacturing



4. Emission limits, monitoring and other provisions

4.1 Emissions of particulate matter, odour and ammonia should be controlled.

4.2 The emission limit values and provisions described in this section are achievable using the best available techniques described in **Table 4.1**. Monitoring of emissions should be carried out according to the method specified in this section or by an equivalent method agreed by the regulator. Where reference is made to a British, European, or International standard (BS, CEN or ISO) in this section, the standards referred to are correct at the date of publication. (Users of this note should bear in mind that the standards are periodically amended, updated or replaced.) The latest information regarding the monitoring standards applicable can be found at the Source Testing Association website. Further information on monitoring can be found in Environment Agency publications, M1 and M2.

4.3 All activities should comply with the emission limits and provisions with regard to releases in **Table 4.1**.

The reference conditions for limits in **Section 4** are: 273.1K, 101.3kPa, without correction for water vapour content, unless stated otherwise.

Table 4.1 should be considered in conjunction with the monitoring paragraphs found later in this section.

4.4 The aim is that any location at or beyond the site boundary is free from offensive odour (subject to the provisions of paragraphs 4.5 and 4.11).

Table 4.1 - Emission limits, monitoring and other provisions					
Row	**Substance**	**Source**	**Emission limits/provisions**	**Type of monitoring**	**Monitoring frequency**
1	Emissions from contained and fugitive sources	Odour	n/a	Determination by process assessment Measure hydrogen sulphides and dimethyl sulphide using gas detector tubes (see paragraph 4.11).	*Daily* *Weekly* plus - Daily during odour incidents -* Daily at times when odour incidents are more likely to occur (see paragraphs 4.4, 4.12 and the odour incident response procedure)*.
2	Prewet and phase 1 compost piles	Oxygen	Oxygen content of substrate is kept at 3% or higher	Oxygen probes	*Continuous except during turning*
Temperature may provide a suitable alternative parameter to monitoring oxygen in Row 2					
3	Goody water tanks Other water tanks liable to go anaerobic	Redox potential of water	-280mV minimum redox potential	Redox probes	In accordance with paragraph 5.12 *Continuous or periodic*
Earned recognition - *Asterisked items* can be monitored less frequently					

Earned recognition

4.5 Where a site complies with paragraph 4.4, then the regulator may reduce monitoring requirements in line with ‘earned recognition’, and the operator maintains the optimised operations and effective process management.

Optimising the process

4.6 The operator should optimise the process (paragraphs 5.3 and 5.11 to 5.18) and maintain effective process management (5.24 to 5.30).

Process assessment

4.7 Where a site causes or receives complaints, then the process should be assessed by the operator and necessary action taken. When complaints are received on the same day as the odour is noticed, the information is likely to be more useful to the operator and the regulator.

Emission assessment

4.8 Where a site causes persistent recurrent strong offensive odour, then the emissions from individual sources on site should be assessed for rate of odour emission. Phasing of enclosure and abatement should be considered, to deal with the most significant source or sources in the first phase.

Monitoring, investigating and reporting

4.9 Continuous monitoring and the related provisions of paragraph 5.10 are most likely to be relevant where there is a significant potential for the tanks to go anaerobic.

4.10 The operator should monitor emissions, make tests and inspections of the activity. The need for and scope of testing, (including the frequency and time of sampling), will depend on local circumstances.

- The operator should keep records of inspections, tests and monitoring, including all non-continuous monitoring, inspections and visual assessments. Records should be:
  - kept on site;
  - kept by the operator for at least two years; **and**
  - made available for the regulator to examine.

- If any records are kept off-site they should be made available for inspection within one working week of any request by the regulator.

4.11 The time and location of measurements of hydrogen sulphide and dimethyl sulphide should be recorded. For routine sampling 5 metres downwind from turning of the substrate should be a suitable position. During odour incident investigations concentrations at the downwind site boundary should also be measured.

Information required by the regulator

4.12 The regulator needs to be informed of monitoring to be carried out and the results. The results should include process conditions at the time of monitoring.

- Adverse results from any monitoring activity (both continuous and non-continuous) should be investigated by the operator as soon as the monitoring data has been obtained. The operator should:

  - identify the cause and take corrective action;
  - clearly record as much detail as possible regarding the cause and extent of the problem, and the remedial action taken.

Visible emissions

4.13 The aim should be to prevent any visible airborne emission other than water vapour from any part of the process. This aim includes all sites regardless of location. Monitoring to identify the origin of a visible emission should be undertaken and a variety of indicative techniques are available.

- All emissions to air should be free from droplets.

Emissions of odour

4.14 The overall aim should be that all emissions are free from offensive odour outside the site boundary, as perceived by the regulator. However, the location of the installation will influence the assessment of the potential for odour impact as local meteorological conditions may lead to poor dispersion conditions.

4.15 Where the site has a low odour impact due to its **remoteness** from sensitive receptors, the escape of offensive odour beyond the installation would be unlikely to cause harm. Assessment of the potential for odour impact beyond the site boundary should take account of all predicted wind directions and weather conditions which are typical of the location in question.

Odour Incidents

4.16 The operator should respond to incidents of odours being detected during the site inspection and to complaints. In cases where offensive odours are detected beyond the process boundary the operator should undertake an assessment of process operations and odour controls.

4.17 The operator should monitor the performance of the installation to ensure that emissions which may result in offensive odours beyond the boundary of the site are not released.

4.18 Where there are problems that, in the opinion of the regulator, may be attributable to the installation, such as local complaints of odour or where odour from the installation is being detected beyond the site boundary, the operator should investigate in order to find out which part of their operation(s) is the cause.

4.19 Whilst problems are ongoing, a boundary check should also be made at least once per day when an installation is being operated. The time, location and result of these checks, along with weather conditions such as indicative wind direction and strength, should be recorded.

4.20 Once the source of the emission is known, corrective action should be taken without delay and where appropriate the regulator may want to vary the permit in order to add a condition requiring the particular measure(s) to be undertaken.

Abnormal events

4.21 The operator should respond to problems which may have an adverse effect on emissions to air.

- In the case of abnormal emissions, malfunction or breakdown leading to abnormal emissions the operator should:
  - investigate and undertake remedial action immediately;
  - adjust the process or activity to minimise those emissions; **and**
  - promptly record the events and actions taken.
- A simple wind direction indicator (such as a windsock or wind vane) should be installed in order that likely emission paths and areas of potential odour impact can be identified in the case of abnormal emissions.
- The regulator should be informed without delay if there is an emission that is likely to have an effect on the local community.

5. Control techniques

Summary of best available techniques

5.1 Mushroom substrate manufacturing has traditionally been carried out in stacks or windrows and a considerable portion of the process is undertaken in the open-air. The phase I operations are usually under cover but this is to assist in moisture control rather than specifically for odour control. It is considered that best available technique for these processes can be summarised as:

- forced aeration of the phase I process either in a building, bunker or tunnel;
- forced aeration of the pre-wet operation;
- management and monitoring of oxygen levels within the substrate during phase I and pre-wet operations;
- the use of bale blenders, pre-wet turners or adapted phase I turners initially (not shovels initially) for blending and wetting in the pre-wet phase of the process;
- bale wetting by immersion, not by spraying.

5.2 The operator is expected to carry out all appropriate techniques in **Table 5.1.**

Full enclosure, including prewet and Phase 1, air extraction and odour abatement are not considered BAT except where there are persistent recurrent strong offensive odour at sensitive receptors.

It is likely that an incremental approach to enclosure would be needed, with odour emission assessment to identify the largest emissions, followed by enclosure of the predominant sources, followed by further reassessment and enclosure as needed.

Abatement of odours by biological methods is likely to need ammonia removal before the gases are passed through biofilters. If non-bio odour abatement is chosen, then ammonia controls should be assessed for their contribution to odour and for any sensitive habitats.

5.3 The following are examples of odour control techniques which would be expected for both new and existing processes:

- avoiding anaerobic conditions;
- good housekeeping and raw material handling practices;
- careful selection and inspection of raw materials;
- control and minimisation of odours from residual materials and waste;
- maintaining the effluent and goody water aerated.

5.4 **Table 5.1** provides a summary of the best available techniques that can be used to control the process in order to meet the emission limits and provisions in **Section 4**. Provided that it is demonstrated to the satisfaction of the regulator that an equivalent level of control will be achieved, then other techniques may be used.

Table 5.1 - Summary of control techniques

Release source	Substance	Control techniques
Loading and unloading processes	Odour, particulate matter	Avoidance of wind entrainment Raw material quality control Covered vehicles and containers
Raw material selection	Odour, ammonia	Selection of materials
Raw material		Located to take account of sensitive receptors Raw material quality Avoid any anaerobic activity
Goody water, collected rainwater and waste storage		Minimise volume of goody water Collect rainwater separately Aerate to maintain tanks aerobic Enclose sludge collection
Pre wet operations		Bale wetting by immersion Mechanical equipment for initial mixing - bale blenders, pre-wet turners or adapted phase I turners Maintain aerobic including oxygen monitoring Forced aeration
Phase I operations		Forced aeration Maintain aerobic including oxygen monitoring
All		Active management, including monitoring and an odour response procedure.

5.5 **Table 5.2** provides a summary of the best available techniques that can be used where there is a persistent recurrence of strong offensive odours at sensitive receptors.

Table 5.2 - Further control techniques for sites with persistent recurrent strong offensive odour offsite

Release source	Substance	Control techniques
Pre wet operations	Odour, ammonia	Assessment of emissions, enclosure, extraction of exhaust gases and abatement of ammonia and odours. Enclosure might be phased, dealing with the largest emission sources first.
Phase I operations	Odour, ammonia	
Definitions of pre-wet and Phase 1 can vary from site to site. The scope of emission assessment should be sufficiently broad and sufficiently detailed to inform an effective and focused approach to phasing enclosure and abatement. For example, 'broad enough' might well include bale dunking in the assessment, and detailed enough to decide that bale dunking should not be included in phase 1 of enclosure and abatement.		

5.6 The primary releases from the process are odours and the release of odours can be greatly reduced by ensuring that the composting operation does not become anaerobic. The potential release points are:

- raw material reception, storage and handling;
- due to accelerated decomposition of the raw materials often due to materials being wet;
- from the application of goody water onto the straw;
- from the storage, handling and transport of the substrate during the composting operation, particularly during mechanical turning and mixing operations;
- from the composting process particularly if the material becomes anaerobic and also during the phase I operation;
- from the storage and disposal of any waste materials;
- from the collection, storage and re-use of liquid effluent (goody water).

5.7 There is the potential for generation of airborne dust from some of the raw materials used in the process (such as gypsum, poultry manure etc.) during windy conditions particularly during delivery, turning and movement within the process.

5.8 There is potential for **ammonia** emissions. If odour abatement by biofilters is installed, then ammonia will need to be abated to prevent damage to the biofauna.

5.9 Emissions of **bio-aerosols** are under investigation from waste composting sites and intensive agriculture, and monitoring methods are being developed further. Results will be reviewed, and further guidance is being considered, but will not be decided without full consultation.

Techniques to control emissions

5.10 Emissions from the operations covered by this note comprise odours of mixed chemical species but particularly amines and sulphur compounds including mercaptans. Ammonia is also emitted. The main principle for preventing odour emissions is maintaining the process under aerobic conditions to ensure they do not result in offensive odours beyond the process boundary.

5.11 The pre-wet and phase I operations should be carried out with forced aeration as detailed in paragraph 5.14.

5.12 The use of odour masking agents and counteractants should not be permitted except as a palliative measure when odour control measures have failed.

Techniques to control fugitive emissions

Raw materials selection and storage

5.13 Maintaining the quality of incoming raw materials will reduce potential odour release during delivery and storage. The selection and introduction of materials that minimise odour production may need to be a continuing process as alternative materials become and then cease to be obtainable. The introduction of new materials may need to be gradual to minimise crop yield reduction. These substitutions are often not possible for organic mushroom production.

- good quality, long straw should be utilised;
- part or all of the poultry manure should be substituted where possible with another source of nitrogen which can be obtained locally eg urea, hop powder, brewers grains;
- other sources of nitrogen should be sought to replace poultry manure;
- the aim should be to substitute 20% of the wheat straw by oil seed rape straw, when it can be obtained.

Maximize replacement of wheat straw by oil seed rape straw, up to 20% of the total straw.

Substitute 25% of poultry manure with other nitrogen sources, subject to obtainability.

Stored quantities of potentially dusty or odorous raw material should be enough for no more than 1 week of manufacturing.

The design and use of vehicles and containers should be such as to prevent spillage and the emission of any offensive odour or substance prescribed for air.

All solid potentially malodorous raw materials-such as horse manure and chicken manure - which are intended to be delivered to the processing site and which are so wet as to be likely to give rise to offensive odour during storage prior to use, should not be accepted at the processing site.

All potentially malodorous solid raw materials should be stored so as to prevent them becoming so wet as to give rise to offensive odour - for example, by sheeting the material or by the provision of covered storage areas. The size of stockpiles should be kept to a minimum and all potentially malodorous raw materials should be used as soon as possible after delivery to the site.

Material storage locations should be located to take account of sensitive receptors and potentially dusty materials should be protected from wind entrainment for example by storage in bunkers or sheeting.

Premix chicken litter with gypsum (where used) before adding to straw.

Prewet and phase 1

5.14 The composting operation should be carried out in such a way as to ensure that organic decomposition proceeds aerobically. Good mixing is important. This will involve optimising the penetration of air into the decomposing material at all times- for example, by ensuring:

- the incorporation of goody water and liquors into the substrate should be achieved by immersion, not by boomspraying;
- that the substrate does not become too wet;
- that the size of individual piles of substrate is optimized;
- the poultry manure is added as late as possible e.g. by splitting the addition;
- the substrate is turned regularly and as often as is necessary to prevent the development of anaerobic conditions;
- forced aeration of the prewet and phase I processes. The forced aeration can be underfloor, or by side feed from wall fans (where practicable);
- that the level of oxygen within the substrate is continuously monitored and recorded and kept at 3% or higher;
- that material blending and turning is achieved initially by the use of bale blenders, pre-wet turners or adapted phase I turners.

Goody water, rainwater and sludge

5.15 The process will usually recycle all effluent for use in the process as goody water. To assess whether the goody water tank is sufficiently aerobic, the redox potential of the goody water is measured; the more anaerobic water is, the more negative the reading will be, eg -320mV is more anaerobic than -220mV. The profile of redox potential variation (derived from monitoring results from sufficient period when monitors are first fitted, and to account for variations such as seasonal weather changes and when there are any significant changes in input materials) will be established by regular checking of monitors and recording of the results. Thereafter, it is likely to be adequate to check and record only to assure that the profile is being maintained, with increased checking in the event of any further process changes and when there are odour incidents. Checking during odour incidents and at times they are more likely to occur may be used to judge how often redox potential needs to be checked in order to aid prevention of such incidents.

Existing goody water tanks should be reassessed for low circulation places where anaerobic conditions can arise.

The quantity of goody water stored should be kept as small as possible.

Collected rainwater should be stored separately until needed to top up the goody water. These tanks should also be kept aerobic.

All potentially malodorous liquids, such as goody water, should be stored in tanks or lagoons, designed and situated to minimise the impact of any odour which is generated. All pipework and channelling which carries such leachate from the process to storage and vice versa should be totally enclosed and maintained free from any leaks. All such pipework and channelling should be fully flushable in situ.

Tanks of goody water and other malodourous liquids should be aerated and the aeration rate measured.

The operator should monitor for, and comply with, the redox potential limit in table 2 and keep a record of results when the monitor is checked. The operator should establish a profile of how redox potential varies:

- when the monitoring is first installed,
- at times which reflect the main operational conditions for the installation,
- when odour incidents occur, and are more likely to occur.

Submersed pipework should be used for aeration. The surface of goody water storage tanks should not be agitated.

Solids should not be allowed to build up in goody water tanks to more than a dry matter content of 8% w/w, solids should be drawn off regularly.

Sludge from goody water tanks and other malodorous waste materials should be held in enclosed storage pending removal from site, or preferably drawn straight into road tankers ready for removal from site. Fixed draw-off points should be provided to liquid storage facilities to facilitate the drawing off of accumulated sludge without the need to open the storage container.

Cleaning and drainage

5.16 All surfaces and equipment liable to come into contact with raw materials or waste and all walls of areas where such materials are handled should be impervious, capable of being readily cleansed and should be kept clean.

Yard surfaces should be impervious, laid to drain and be free from surface imperfections to ensure free flow of effluent and rainwater and avoid the collection and possible stagnation of liquids.

All floors of processing and storage areas should be of impervious construction laid to fall to the effluent collection system and trapped drainage inlets should be provided where necessary, with sedimentation tanks and interceptors to prevent the transmission of material likely to impair the free flow of any receiving effluent system.

5.17 Good housekeeping should be practised at all times. The adoption of good cleaning and working practices as a routine will reduce process odour emissions . A proper cleaning programme should be instituted. This should cover all structures, equipment and internal surfaces and containers used for animal matter processing and collection and waste storage. The cleaning of all drainage areas and collecting tanks, yards and roads should be undertaken regularly and at least once a week.

Air quality

Dispersion & dilution

Ambient air quality management

5.18 In areas where air quality standards or objectives are being breached or are in serious risk of breach and it is clear from the detailed review and assessment work under Local Air Quality Management that the permitted process itself is a significant contributor to the problem, it may be necessary to impose tighter emission limits. If the standard that is in danger of being exceeded is not an EC Directive requirement, then industry is not expected to go beyond BAT to meet it. Decisions should be taken in the context of a local authority's Local Air Quality Management action plan. For example, where a permitted process is only responsible to a very small extent for an air quality problem, the authority should not unduly penalise the operator of the process by requiring disproportionate emissions reductions. Paragraph 59 of the Air Quality Strategy 2007 [Volume 1] gives the following advice:

"...In drawing up action plans, local authority environmental health/pollution teams are expected to engage local authority officers across different departments, particularly, land-use and transport planners to ensure the actions are supported by all parts of the authority. In addition, engagement with the wider panorama of relevant stakeholders, including the public, is required to ensure action plans are fit-for-purpose in addressing air quality issues. It is vital that all those organisations, groups and individuals that have an impact upon local air quality, buy-in and work towards objectives of an adopted action plan."

Management

Management techniques

5.19 Important elements for effective control of emissions include:

- proper management, supervision and training for process operations;
- proper use of equipment;
- effective preventative maintenance on all plant and equipment concerned with the control of emissions to the air; **and**
- ensuring that spares and consumables - in particular, those subject to continual wear – are held on site, or available at short notice from guaranteed local suppliers, so that plant breakdowns can be rectified rapidly. This is important with respect to arrestment plant and other necessary environmental controls. It is useful to have an audited list of essential items.

Appropriate management systems

5.20 Effective management is central to environmental performance; it is an important component of BAT and of achieving compliance with permit conditions. It requires a commitment to establishing objectives, setting targets, measuring progress and revising the objectives according to results. This includes managing risks under normal operating conditions and in accidents and emergencies.

It is therefore desirable that installations put in place some form of structured environmental management approach, whether by adopting published standards (ISO 14001 or the EU Eco Management and Audit Scheme [EMAS]) or by setting up an environmental management system (EMS) tailored to the nature and size of the particular process. Operators may also find that an EMS will help identify business savings.

5.21 Regulators should use their discretion, in consultation with individual operators, in agreeing the appropriate level of environmental management. Simple systems which ensure that LAPPC considerations are taken account of in the day-to-day running of a process may well suffice, especially for small and medium-sized enterprises. Regulators are urged to encourage operators to have an EMS for all their activities, but it is outside the legal scope of an LAPPC permit to require an EMS for purposes other than LAPPC compliance. For further information/advice on EMS refer to the appropriate chapter of the appropriate Guidance Manual for England and Wales, Scotland and Northern Ireland.

Liaison manager

5.22 A senior manager who recognises the importance of controlling the odours produced by mushroom substrate manufacturing should be designated to be specifically responsible for all aspects of liaison with the regulator and where applicable with members of the general public.

Training

5.23 Staff at all levels need the necessary training and instruction in their duties relating to control of the process and emissions to air. In order to minimise risk of emissions, particular emphasis should be given to control procedures during start-up, shut down and abnormal conditions. Training may often sensibly be addressed in the EMS referred to above.

- All staff whose functions could impact on air emissions from the activity should receive appropriate training on those functions. This should include:
  - awareness of their responsibilities under the permit;
  - steps that are necessary to minimise emissions during start-up and shutdown;
  - actions to take when there are abnormal conditions, or accidents or spillages that could, if not controlled, result in emissions.
- The operator should maintain a statement of training requirements for each post with the above mentioned functions and keep a record of the training received by each person. These documents should be made available to the regulator on request.

Maintenance

5.24 Effective preventative maintenance plays a key part in achieving compliance with emission limits and other provisions. All aspects of the process including all plant, buildings and the equipment concerned with the control of emissions to air should be properly maintained. In particular:

- The operator should have the following available for inspection by the regulator:
  - a written maintenance programme for all pollution control equipment; **and**
  - a record of maintenance that has been undertaken.
- All external pipework used for cleaning water, irrigation water and process liquid transfer should be protected against frost.

Odour response procedure

5.25 The operator should prepare an odour response procedure. This is a summary of the foreseeable situations which may compromise his ability to prevent and/or minimise odorous releases from the process and the actions to be taken to minimise the impact. It is intended to be used by operational staff on a day-to-day basis and should detail the person responsible for initiating the action. **Appendix 1** gives some further guidance on preparing an odour response procedure.

6. Summary of changes

The main changes to this note, with the reasons for the change, are summarised in **Table 6.1**. Minor changes that will not impact on the permit conditions e.g. slight alterations to the Process Description have not been recorded.

Table 6.1 - Summary of changes

Section/ paragraph/ row	Change	Reason	Comment
Table 5.2	Added assess emissions and consider enclosure and abatement if there is persistent recurrence of strong offensive odour	BAT	Unlikely to be needed at small sites
Appendix 2	Added provisions about abatement plant	To provide guidance on abatement plant	Similar provisions to other PG Notes that have containment and abatement

7. Further information

Sustainable consumption and production (SCP)

Both business and the environment can benefit from adopting sustainable consumption and production practices. Estimates of potential business savings include:

- £6.4 billion a year UK business savings from resource efficiency measures that cost little or nothing;
- 2% of annual profit lost through inefficient management of energy, water and waste;
- 4% of turnover is spent on waste.

When making arrangement to comply with permit conditions, operators are strongly advised to use the opportunity to look into what other steps they may be able to take, for example, having regard to the efficient use of auxiliary fuels, such as gas and electricity. Regulators may be willing to provide assistance and ideas, although cannot be expected to act as unpaid consultants.

Health and safety

Operators of installations must protect people at work as well as the environment:

- requirements of a permit should not put at risk the health, safety or welfare of people at work or those who may be harmed by the work activity;
- equally, the permit must not contain conditions whose only purpose is to secure the health of people at work. That is the job of the health and safety enforcing authorities.

Where emission limits quoted in this guidance conflict with health and safety limits, the tighter limit should prevail because:

- emission limits under the relevant environmental legislation relate to the concentration of pollutant released into the air from prescribed activities;
- exposure limits under health and safety legislation relate to the concentration of pollutant in the air breathed by workers;

- these limits may differ since they are set according to different criteria. It will normally be quite appropriate to have different standards for the same pollutant, but in some cases they may be in conflict (for example, where air discharged from a process is breathed by workers). In such cases, the tighter limit should be applied to prevent a relaxation of control.

Further advice on responding to incidents

The UK Environment Agencies have published guidance on producing an incident response plan to deal with environmental incidents. Only those aspects relating to air emissions can be subject to regulation via a Part B (Part C in NI) permit, but regulators may nonetheless wish to informally draw the attention of all appropriate operators to the guidance.

It is not envisaged that regulators will often want to include conditions, in addition to those advised in this PG note, specifying particular incident response arrangements aimed at minimising air emissions. Regulators should decide this on a case-by-case basis. In accordance with BAT, any such conditions should be proportionate to the risk, including the potential for harm from air emissions if an incident were to occur. Account should therefore be taken of matters such as the amount and type of materials held on site which might be affected by an incident, the likelihood of an incident occurring, the sensitivity of the location of the installation, and the cost of producing any plans and taking any additional measures.

Appendix 1 - Preparation of an odour response procedure

What is an odour response procedure?

An odour response procedure is a summary, provided by the operator, of the foreseeable situations which may compromise his ability to prevent and/or minimise odorous releases from the process and the actions to be taken to minimise the impact. It is intended to be used by operational staff on a day-to-day basis and should detail the person responsible for initiating the action.

The procedure is intended primarily to document foreseeable events which once they have occurred are to some extent outside of the control of the operator and those that are preventable by maintenance and operational control (for example pump failure). The procedure should include a maintenance programme for all odour related equipment).

What is the format for the odour response procedure?

The odour response procedure should be a written document which is available on-site and should be submitted to the regulator. The regulator may wish to set conditions in the permit/authorisation which reflect the undertakings given in the procedure.

What should be included in the odour response procedure?

There are two main reasons for releases which may lead to emissions of offensive odour which are:

- changes in process conditions leading to more odour generation or a change in the odour characteristics;
- factors affecting the dispersion between the source and the receptor.

Examples of issues which should be considered in each of these categories are given in the **Table A**.

In order to prepare an assessment of possible abnormal conditions and the options for mitigation of the odour, the operator will need to consider:

- the activity which produces the odour and the point of odour release;
- possible process or control failures or abnormal situations;
- potential outcome of a failure in respect of the likely odour impact on local sensitive receptors;
- what actions are to be taken to mitigate the effect of the odour release and details of the persons responsible for the actions at the site.

Table A - Examples of issues to consider relating to odour release	
Factors leading to odour release	**Examples of issues to consider**
Those which have potential to affect the process and the generation of odour	Materials input - seasonal variation in weather or material availability of alternatives may affect odour of process. Process parameters such as changes in temperature/oxygenation Rate of throughput High levels of ammonia/sulphides within the process (possibly due to high ambient temperatures / insufficient aeration).
Those affecting dispersion between the source and sensitive receptors‡	Short term weather patterns which fall outside of the normal conditions for that area and are highly unusual (not just the normal meteorological pattern) - inversions and other conditions unfavourable to dispersion should have been considered in designing the process Weather - wind direction, temperature, inversion conditions if these are normal variants of local weather Loss of plume buoyancy/temperature
‡ The process design should incorporate control measures to ensure that under the normal range of meteorological conditions for the area, no emissions result in offensive odour that is detectable beyond the process boundary.	

Appendix 2 - Additional provisions for odour and ammonia abatement

Odour and ammonia abatement plant is rare at mushroom substrate processes; for those sites with odour and ammonia abatement plant, this appendix should be read as a continuation of **sections 4** and **5**.

Emission limits, monitoring and other provisions - continued

- Re-test to demonstrate compliance as soon as possible; and inform the regulator of the steps taken and the re-test results.

  - The operator should notify the regulator at least 7 days before any periodic monitoring exercise to determine compliance with emission limit values. The operator should state the provisional time and date of monitoring, pollutants to be tested and the methods to be used.

  - The results of non-continuous emission testing should be forwarded to the regulator within 8 weeks of completion of the sampling.

1. Where it is installed any odour arrestment equipment should be inspected at least once a day to verify correct operation and to identify any malfunctions. Depending upon the type of any arrestment plant used this inspection should include:

   - Identification of any leaks in air handling equipment and ductwork.

   - In the case of scrubbing equipment, thermal oxidisers and other combustion equipment, the inspection should include verification of the operation of any continuous monitoring equipment, the presence of any blockages and also identification of any leaks of either odorous air or liquid.

   - In the case of biofilters, the surface should be inspected to identify any cracking of the surface or voids in the bed, leaks around the edge of the filter or air handling equipment, review of the moisture content (considering both flooding and drying out) and looking for signs of compaction or uneven flow.

   - In the specific case of soil biofilters, the growth of plants and weeds should be inspected as any excessive flow or odour escape is often indicated by scorching of the earth or plant growth dying off.

- In the event of the failure of key arrestment plant, for example, bag filtration plant or scrubber units the operator should provide a list of key arrestment plant and should have a written procedure for dealing with its failure, in order to minimise any adverse effects.

Continuous monitoring

1. Continuous monitoring can be either “quantitative” or “indicative”.

2. Where continuous indicative monitoring has been specified, the information provided should be used as a management tool. The regulator may wish to agree any alarm trigger levels.

3. Where continuous monitoring is required, it should be carried out as follows:

   - All continuous monitoring readings should be on display to appropriately trained operating staff.

   - Instruments should be fitted with audible and visual alarms, situated appropriately to warn the operator of arrestment plant failure or malfunction.

   - The activation of alarms should be automatically recorded.

   - All continuous monitors should be operated, maintained and calibrated (or referenced, in the case of indicative monitors) in accordance with the manufacturers’ instructions, which should be made available for inspection by the regulator.

   - The relevant maintenance and calibration (or referencing, in the case of indicative monitors) should be recorded.

   - Emission concentrations may be reported as zero when the plant is off and there is no flow from the stack. If required a competent person should confirm that zero is more appropriate than the measured stack concentration if there is no flow.

   Any continuous monitor used should provide reliable data >95% of the operating time, (i.e. availability >95%). A manual or automatic procedure should be in place to detect instrument malfunction and to monitor instrument availability.

Calibration and compliance monitoring

4. Compliance monitoring can be carried out either by use of a continuous emissions monitor (CEM) or by a specific extractive test carried out at a frequency agreed with the regulator.

5. Exhaust flow rates should be consistent with efficient capture of emissions, good operating practice and meeting the requirements of the legislation relating to the workplace environment.

   - The introduction of dilution air to achieve emission concentration limits should not be permitted.

   Dilution air may be added for improved dispersion.

Representative sampling

6. Whether sampling on a continuous or non-continuous basis, care is needed in the design and location of sampling systems, in order to obtain representative samples for all release points.

Control techniques - continued

Stacks, vents and process exhausts

1. Liquid condensation on internal surfaces of stacks and exhaust ducts might lead to corrosion and ductwork failure or to droplet emission. Adequate insulation will minimise the cooling of waste gases and prevent liquid condensation by keeping the temperature of the exhaust gases above the dewpoint. A leak in a stack/vent and the associated ductwork, or a build up of material on the internal surfaces may affect dispersion:

   - Flues and ductwork should be cleaned to prevent accumulation of materials, as part of the routine maintenance programme.

2. When dispersion of pollutants discharged from the stack (or vent) is necessary, the target exit velocity should be 15m/s under normal operating conditions, (see also the paragraph below regarding wet plumes). In order to ensure dispersion is not impaired by either low exit velocity at the point of discharge, or deflection of the discharge, a cap, or other restriction, should not be used at the stack exit. However, a cone may sometimes be useful to increase the exit velocity to achieve greater dispersion.

3. An exception to the previous paragraph is where wet arrestment is used as the abatement. Unacceptable emissions of droplets could occur from such plant where the linear velocity in the stack exceeds 9m/s.

4. To reduce the potential of droplet emissions a mist eliminator should be used. Where a linear velocity of 9m/s is exceeded in existing plant consideration should be given to reducing this velocity as far as practicable to ensure such droplet entrainment and fall out does not happen.

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Appendix 3 - Method for sampling of emissions from biological (earth, peat and heather) filters using gas detection tubes

1. Routine monitoring of emissions from biological filters can be readily undertaken using gas detection tubes. However, it is important to ensure that a number of representative samples are obtained and that care is taken in the interpretation of results. The number of samples necessary will depend upon the gas distribution within the biological filter.

2. It is essential that samples are taken from a representative volume of emitted gas as near surface dispersion will significantly affect measured concentrations. Therefore, it is necessary to reduce dispersion and obtain a volume of gas from which to sample. This can be achieved by placing a purpose-made enclosure on top of the filter bed and allowing the emitted gases to accumulate.

3. The enclosure itself should be approximately 0.5 m^3 - 1 m^3 in volume, preferably with a 1 m square open base. The top of the enclosure should have an opening of approximately 50 mm diameter to facilitate sampling. The enclosure call be simply fabricated using a timber frame and plywood or hardboard sides and top with mastic or other suitable sealant applied to the side and top joints.

4. It will be extremely difficult to achieve a seal at the filter bed surface, however the enclosure should be located in order to minimise leakage from the points of contact with the filter bed. The enclosure should remain at the sample location for at least 10 minutes prior to sampling to ensure that a representative sample of emissions is obtained (allowing the volume of the enclosure to be purged three times).

5. The gas detection tubes should be used in accordance with the manufacturer's instructions and results should be evaluated against the indicative guide values in **Table 4.2**. Amines and amides are a common interference with gas detection tubes for ammonia and therefore results obtained from ammonia gas detection tubes should be compared to a 2 ppm v/v indicative guide value. It may be necessary to monitor for hydrogen sulphide and mercaptans separately depending upon the detector tube specification and in this case the sum of the individual results should be compared with the indicative guide value in Row 3 of **Table 4.2**.

6. This method is only suitable for open biomass type biofilters where no final discharge vent or stack exists.

Additional information is available in BS EN13725 - "Air Quality - Determination of Odour Concentration by Dynamic Olfactometry" and "Odour Measurement and Control-:An Update "published by National Environmental Technology Centre, Culham, Abingdon. Oxon OX14 3DB. ISBN 0-85624--8258.