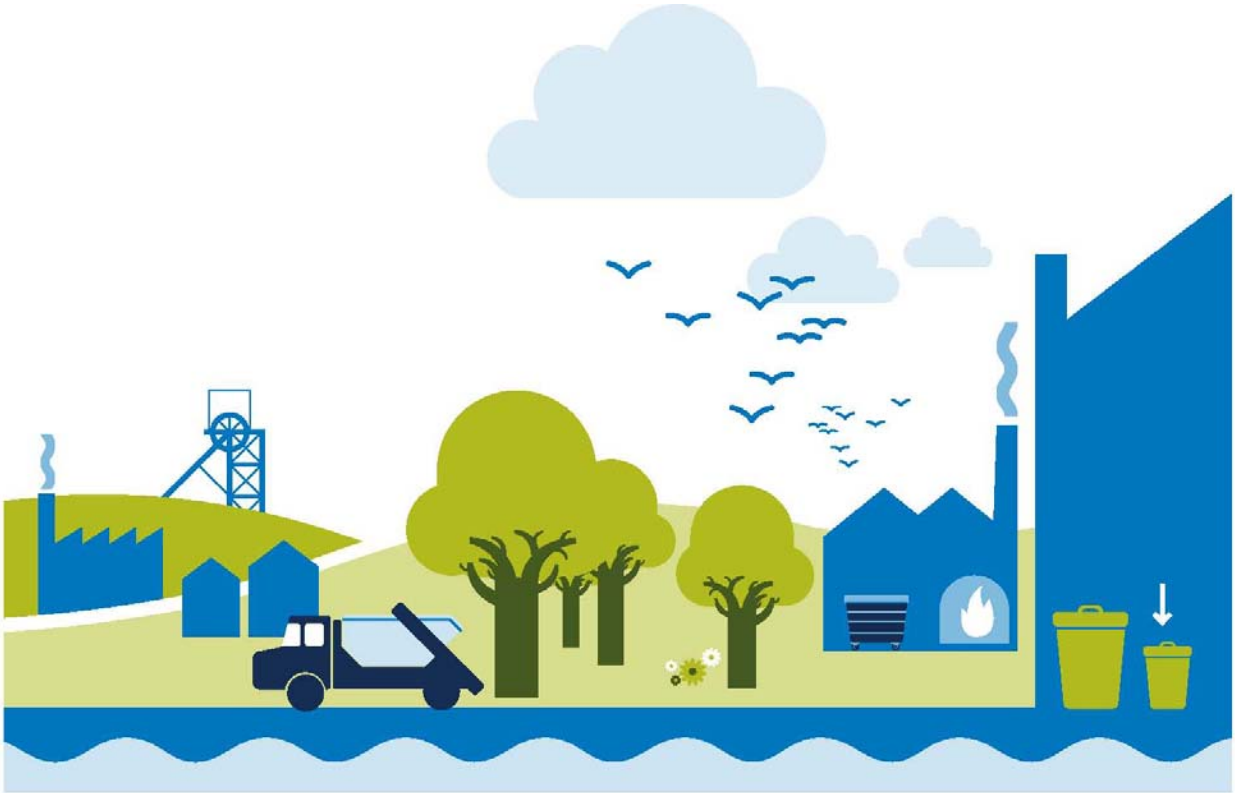
Additional guidance for

H4 Odour Management

How to comply with your environmental permit



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GEHO0411BTQM-E-E

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1. Introduction

This document is part of a suite of guidance notes issued by the Environment Agency[1]. These notes are designed to help both holders and potential holders of permits understand how to apply for, vary and comply with their permits. This document supersedes the previous draft H4 guidance and the Environment Agency's internal guidance on the management of odour at waste facilities.

The top level in this suite is *How to Comply with your Permit* which covers a large proportion of what an operator needs to know. There are then notes that cover issues specific to particular business sectors, and "horizontal" notes that go into more detail on particular topics such as risk assessment, noise or odour. H4 is one of these "horizontal" topic notes. Click here[2] to see a complete list of the sector and "horizontal" notes, which are all available from our website.

The Environmental Permitting Regulations (the "EP Regulations") require the control of pollution including odour. This guidance covers our regulatory requirements with regard to odour, advice on the management of odour and the aspects that should be dealt with in an odour management plan (OMP). This guidance does not apply to UWWTD[3] facilities (unless they are subject to the IPPC Directive), standalone water discharges, groundwater authorisations, radioactive substance activities or any other activity which is not subject to an odour condition in a permit.

If you are making a new application you should first refer to the Environmental Permitting application form which will lead you through the necessary steps. Click here[4] for the application form and guidance.[5]

[1] In consultation with NIEA. For the legislative framework in Northern Ireland contact NIEA at www.ni-environment.gov.uk

[2] Link to EPR guidance - http://www.environment-agency.gov.uk/business/topics/permitting/36414.aspx

[3] UWWTD – Urban Waste Water Treatment Directive

[4] Link to application form - http://www.environment-agency.gov.uk/business/topics/permitting/32318.aspx

[5] Contact NIEA for the equivalent in N. Ireland

Your permit conditions

2. Your permit conditions

For an explanation of how our approach to permitting delivers the requirements set out in legislation see *RGN4 - Setting Standards in Environmental Permits*.

Depending on its age, your permit may express an odour condition using different terms. For example, the permit may state that the operator must not cause nuisance, annoyance, offensive odours, offence to man's senses, interference with amenities, pollution etc. It may require the use of Best Available Techniques (BAT), appropriate measures, due diligence or all reasonable precautions to minimise odour.

The relevant legislation also uses a variety of terminology. For example, the Landfill Directive says "*Measures shall be taken to minimise nuisances and hazards arising from the landfill through emissions of odours*", whereas the IPPC Directive includes odour in the definition of pollution and says "…..*all the appropriate preventive measures are taken against pollution …..".*

Whichever form of words is used in the permit we will treat it as having the same meaning as explained in Section 3. Accordingly, in this Guidance when we refer to the obligation not to cause pollution and the requirement to use appropriate measures we intend these expressions to encompass all the terms referred to above that may be found in the various odour conditions.

In other words, appropriate measures will be those that are required by the relevant legislation. For example, for IPPC installations, they will be BAT as defined in the IPPC/IED Directives or for waste sites they will be the "relevant objectives" as defined in the Waste Framework Directive. In most cases, however, the standard that is required for the control of odour will be the same.

We would not require you to go beyond appropriate measures unless serious pollution was being caused. However, appropriate measures may require more measures to be taken where the risk of pollution is greater. Furthermore, there may be circumstances where you may choose to apply innovative methods which are not yet recognised as BAT, but which you consider to be necessary to solve a particular problem.

2.1 The Conditions

The current form of odour condition used in our 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 OMP (where activities are considered likely to give rise to odour)

There may also be specific operational conditions relating to odour control which require certain techniques or specify emission limits.

The Odour Boundary Condition

> *Emissions from the activities shall be free from odour at levels likely to cause pollution outside the site, as perceived by an authorised officer of the Agency, unless the operator has used appropriate measures, including, but not limited to, those*

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specified in an approved odour management plan, to prevent or where that is not practicable to minimise the odour.[6]

You must employ the appropriate measures necessary to prevent the odour pollution or minimise it when prevention is not practicable. The measures that are appropriate will depend on your industry sector and your site-specific circumstances and will take costs and benefits into account.

The underlined portion of the odour boundary condition ensures that operators will not be in breach of that condition provided they are using appropriate measures. However, even if the operator is using all appropriate measures, if we consider the residual odour is at such a level that it is unreasonable it will be necessary for the operator to take further measures to reduce odour pollution or risk having to reduce or cease operations. Where the residual odour pollution is, or is likely to be, unacceptable we will work closely with operators to help them find solutions that will avoid this eventuality.

The condition and the benchmarks given in this guidance are based on odour levels at the boundary. If there are no receptors close to the boundary we will normally permit a facility that meets the criteria at the nearest receptor.

However even where the facility has not caused odour problems in the past the operator may have to take action to prevent or, where that is not practicable, minimise actual or potential odour pollution if circumstances change e.g. a new residential development is built near to the site boundary. You may decide to design to the tighter (boundary) standard to future-proof your investment.

Figure 1 illustrates this approach.

Figure 1- Three levels of odour

Unreasonable odour amounting to serious pollution is being or is likely to be caused (regardless of whether appropriate measures are being used). You must take further action or you may have to reduce or cease operations. The Environment Agency would not issue a permit if it considered that you were likely to be operating at this level.
Odour pollution is or is likely to be caused beyond boundary. **Your duty** is to use appropriate measures to minimise odour. **You are not in breach** if you are using appropriate measures. If appropriate measures are being used, residual odour will have to be tolerated by the community. For some activities appropriate measures will achieve no smell beyond the boundary.
No odour beyond the boundary or likely to be = no pollution = no action needed

From consideration of Figure 1 it will be evident that, in any particular case, we have to decide:

Step 1: whether or not unreasonable odour pollution is being or is likely to be caused, even if appropriate measures are used, and

[6] If an existing permit contains an odour boundary condition without the appropriate measures defence, we shall act as though it were present. An operator may have a non-chargable variation to include this provision, although this is not necessary to provide protection. The provision will be added when a permit comes up for review or variation for any other reason.

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Step 2: if the odour pollution is not or is not likely to be at the unreasonable level, whether appropriate measures are being used

Section 3 describes how to go about assessing these two steps.

An OMP (where required) plays a part in identifying the appropriate measures for a particular site. However, an OMP may not contain all the appropriate measures that need to be used, particularly if it has not been recently reviewed or circumstances have changed.

The Odour Management Plan Conditions

For the activities listed in Annex 2 of *How to Comply with your Permit* which are likely to give rise to odour problems an OMP has to be submitted for approval as part of the permitting process. There is a general operational condition (2A), in such permits, that requires the operator to comply with this plan and to submit revisions of the plan in the future, should this prove necessary.

2A ***(a) The activities shall, subject to the conditions of this permit, be operated using the techniques and in the manner described in the documentation specified in Schedule 1, Table S1.2, unless otherwise agreed in writing by the Environment Agency.***

(b) If notified by the Environment Agency that the activities are giving rise to pollution, the operator shall submit to the Environment Agency for approval within the period specified, a revision of any plan specified in Schedule 1, Table S1.2 or otherwise required under this permit, and shall implement the approved revised plan in place of the original from the date of approval, unless otherwise agreed in writing by the Agency.

Permits for sites carrying out activities that have a low odour risk will contain condition 2B below, which allows us to require an OMP should there be an unexpected odour problem after the permit has been granted.

2B. *The operator shall:*

(a) if notified by the Environment Agency that the activities are giving rise to pollution outside the site due to odour, submit to the Environment Agency for approval within the period specified, a new or revised odour management plan;

(b) implement the approved odour management plan, from the date of approval, unless otherwise agreed in writing by the Environment Agency.

The provisions of your OMP are treated as part of your permit and must be complied with. Compliance with your approved OMP will usually be an excellent way of showing that your process is being properly controlled.

All OMPs should, as a minimum, include the information contained in Appendix 4.:It should clearly demonstrate your competence and commitment to controlling odour pollution. It should be apparent that you understand how your process could give rise to odour pollution and that you have the capability to manage that risk effectively.

You should review the effectiveness of your odour control measures at least once a year. This interval may be shorter if there have been complaints or relevant changes to your operations or infrastructure.

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Information as to the appropriate measures we would normally expect an operator to have taken is provided in Section 4 and in sector guidance. For some sectors we have also prepared example or template OMPs.

2.2 Approval of odour management plans

When we approve your OMP we will agree the scope and suitability of key measures but this should not be taken as confirmation that the details of equipment specification design, operation and maintenance are suitable and sufficient. That remains your responsibility.

If we consider your OMP is deficient in certain aspects or it does not contain all the necessary appropriate measures we will ask you to amend it to include these. If you decline to do so we may:

- approve your plan subject to additional requirements or provisos (we would only do this for minor aspects);
- approve your OMP in as far as it goes but set out in writing the ways in which we consider it to be deficient and, in particular, which additional appropriate measures you should be taking. If an odour pollution incident occurs as a result of your failure to take any of these additional appropriate measures then it will be more difficult for you to demonstrate that you were using appropriate measures in any subsequent enforcement action;
- impose a requirement on you. However we would only do this by a method that you will have the right to appeal, e.g. a permit condition or enforcement notice;
- where the OMP is submitted as part of an application, we may consider it necessary to refuse that application.

We recognise that no OMP can cover every eventuality and even if you are taking all the appropriate measures specified in your approved OMP, odour pollution may occur. We would usually regard this as an indication that there are now further appropriate measures that need to be taken. In these circumstances we will normally give you a reasonable period of time to make proposals and/or implement improvements to resolve the problem. Exceptions to this might be when odour pollution is caused by you not having specified, designed, operated, maintained and otherwise managed a measure in the OMP or by something not in the OMP that you could and should have reasonably foreseen, for example, the wrong liquids were mixed causing a major release. The inset box gives a specific example of such a situation.

Example: breach of the odour condition despite having an approved OMP

For a landfill: your OMP proposes gas scavenger lines of given diameters and extraction fans of a given capacity for the extraction of landfill gas. If these parameters prove in practice to be insufficient we will work towards a solution with you. If, however, the fans fail because of a design flaw, poor maintenance, inadequate training or because you just decide to turn them down to save costs resulting in a significant odour incident then you may be in breach of your permit condition. A design flaw that would put you in breach of your odour permit condition would be one that should have been picked up as a matter of reasonable due diligence or would be considered to be normal good practice.

If you need to carry out rapid action to solve an odour problem, it is possible that your actions may contravene something in your OMP. Clearly the priority is to take the necessary action to solve the problem. You should do this and bring the OMP up to date after the event.

Assessing the level of odour pollution and appropriate measures

3. Assessing the level of odour pollution and appropriate measures

As stated in Section 2, whichever terms are used in the odour condition in your permit (e.g. nuisance or annoyance) we will interpret these as meaning pollution.

Pollution is an emission which may be harmful to human health or the quality of the environment, cause offence to a human sense or impair or interfere with amenities or other legitimate uses of the environment.[7]

A final determination as to whether there has been a permit breach will involve an assessment of the level and effect of the emissions and the appropriateness of the measures being employed.

Referring to Figure 1, there are two key steps in assessing the level of odour pollution and appropriate measures.

Step 1: Is there serious pollution?

Whether or not odour emissions amount to serious pollution depends on a number of factors. There is no single method of reliably measuring or assessing odour pollution, and any conclusion is best based on a number of pieces of evidence.

The **FIDOR**[8] acronym is a useful reminder of the factors that will determine the degree of odour pollution

- Frequency of detection;
- **I**ntensity as perceived[9];
- **D**uration of exposure;
- Offensiveness[10];
- Receptor sensitivity

Frequency and duration can be assessed from emissions and process control data, wind direction data, complaints and odour diaries

Exposure intensity can be assessed from monitoring information for example:

- sniff testing (which gives a judgement of intensity and offensiveness);
- the use of a field dilution olfactometer;
- complaints and odour diaries;
- emissions or ambient air monitoring where feasible.

For new proposals the expected exposure arising from different options can be estimated through, for example:

- modelling to the standards given in Appendix 3;

[7] The definition of pollution is set out in Regulation 2 of the EP Regulations.

[8] The term FIDOL is sometimes used instead, in which the L stands for Location (of receptors).

[9] **The intensity** of an odour is a logarithmic function of its concentration. So increasing the concentration of an odorous chemical or mixture by a factor of 10 might increase its perceived intensity by a factor of about 2. Conversely, if a site causes odour pollution, abatement equipment might need to remove ~90 per cent of the odour-causing substances in order to halve the intensity of odour as perceived in the community. Adaptation means that the perceived intensity of an odour diminishes rapidly with constant exposure.

[10] **The offensiveness** of an odour includes its hedonic tone. Offensiveness takes account of exposure and the attributes that determine nuisance sensitivity whereas hedonic tome is measured in a laboratory situation aimed simply at “like” or “dislike”.. The hedonic tones for common odours are in Appendix 2 Table A2.1.

- evidence of other similar operations carried out in similar circumstances - when making these comparisons you should take into account the degree of relevance of the comparative sites, in particular:
  - the comparative site may have different weather and dispersion conditions (including topography);
  - odorous emissions can differ in frequency, intensity, duration or offensiveness because of different feedstock materials, operating conditions or engineering differences;
  - the quality of monitoring data at the comparative site may be poor or no such data may be available;
  - the community affected by the proposed site may be more or less tolerant or further away than that at the comparative site.

For some sectors example emission rates may be available, e.g. there are published isopleths for pig farms.

All evidence will need to be carefully considered to ensure that sites are indeed comparable and that measurement uncertainties have been taken into account.

Offensiveness: some odours are generally regarded as more unpleasant than others and therefore need to be subject to greater control. For more information see Appendix 3.

Receptor sensitivity (Location) needs to be considered carefully

- Some receptors are more sensitive than others. Domestic residences, or a pub with a beer garden are more likely to be sensitive than an industrial complex or passers-by.
- Some individuals will be extremely tolerant of odours at high intensities while others will be unable to tolerate an odour as soon as they identify it. Evidence that, for example, only one person finds the odour unacceptable whereas most others, similarly exposed, find it acceptable in that context (e.g. in a rural village) would be relevant to the assessment of the degree of pollution.
- There are a very small number of people (e.g. Addison's sufferers), who have conditions which put them well outside the normal range of sensitivities (see Appendix 2 Figure A2.1) and make them able to detect very low concentrations of odour. We would not expect an operator to design a system to satisfy those individuals.
- The degree of pollution increases with the size of the exposed population. Therefore, the more people that are affected the greater will be the justifiable expenditure on control measures. However, even if only a very small number of individuals are affected, the seriousness of the exposure may require further control measures.
- For new proposals, an assessment should be made of the sensitivity of existing and likely future receptors e.g. complaints history, local development plans etc.

People living near odorous sites often express concerns about possible health impacts from the odours they perceive. We will consult with the Health Protection Agency (HPA)/Public Health Wales (PHW) in relation to public health issues as described in our joint Working Together Agreement.

Assessing the level of odour pollution and appropriate measures

Step 2: Is the operator taking appropriate measures?

Whether you are using all appropriate measures or BAT needs to be informed by a combination of:

- BREFS (where available – click here for list);
- the relevant sections of this guidance;
- more specific guidance including Environment Agency sector guidance notes (click here for list);
- information on other techniques employed in the sector such as industry guidance, and best practice.

When determining what the appropriate measures will be for a site we will factor in needs, costs and benefits. In practice this means that the higher the level of pollution (assessed in accordance with the criteria set out in Step 1 above), the more measures you will be expected to take and the greater the justifiable financial investment will be.

In summary, and as outlined in Figure 1, this approach will result in the following scenarios:

- Where no odour is detectable, or likely to be detectable, beyond the boundary of your site there will be no pollution, and no further action in relation to odour pollution will be required;
- Where odour is detectable, it may or may not cause offence and our response will depend upon the degree of pollution and the cost and practicability of any remedial measures.
- Where all appropriate measures are being used but are not completely preventing odour pollution, a level of residual odour will have to be accepted.
- Where the odour is serious, even if all efforts have been made to apply BAT/appropriate measures, it may be necessary to suspend or revoke your permit in full or in part.

The degree of residual odour that one would expect from an activity that is using all appropriate measures (BAT) will vary from sector to sector, as it is easier to control odour in some sectors than others. For some activities there should be no odour at all beyond the boundary.

If you have, or are likely to have, an odour problem then you should set out in your odour management plan the appropriate measures you intend to use. The following sections give advice on how to do that.

4. Control measures

Your OMP will need to consider the measures you will take to control odour. This guidance provides a general explanation of how you should tackle odour issues and describes types of control measures and plant that should be considered to prevent or abate pollution. However, it does not consider the detail of plant design, operation or maintenance. We expect operators to be knowledgeable of current appropriate measures in their sector. Some of the current measures specific to particular sectors are given in sector guidance.

We advise you to take a systematic approach, considering all measures under each of the following headings and giving priority to controls that can be used at the earliest possible stage in the process:

- Managing inventory
- Controlling evaporation
- Containment and abatement
- Dispersion
- Reducing impacts

The most effective strategies may or may not involve large capital investment, but most measures will need careful management. The ultimate action for you to take is likely to be reducing or stopping odour-causing activities altogether, at least until circumstances change, or you have resolved the problem.

Technology and BAT/appropriate measures are constantly changing. You should use the latest and most effective control measures available for your industry sector. You should base your decisions on the appropriate measures for your industry, taking costs and benefits into account. . However, it is unlikely that we would expect you to upgrade your equipment just because better plant comes along, as long as your existing measures are proving effective.

4.1 Receipt and management of odorous materials

Many feedstock materials, particularly putrescible wastes or animal by-products, can become very odorous before they arrive at your site. You should liaise with your feedstock suppliers about this. For example, for waste management facilities, your contracts may need to specify:

- which types of waste the processing plant or local authority collection teams will receive, and which they will reject;
- how long the waste can be held before it is delivered;
- storage and treatment conditions;
- any appropriate pre-treatment before the waste is dispatched;
- transport conditions (refrigeration, for example);
- the need to divert wastes if you have operational difficulties or you've exceeded your capacity.

In any case you should:

- treat odorous materials promptly in a way which reduces their odour potential;
- keep odorous materials on site to a minimum, rotating stock where appropriate;

- generate as little extra odorous chemicals as possible by, for example, minimising temperatures or maintaining aerobic conditions;
- consider your housekeeping regime and select building materials which can be easily cleaned.

If this is not enough, then you should have procedures in place so that you can identify and reject highly odorous wastes.

Some sites will be specifically designed to manage odorous feedstock materials, or materials over which they have more limited control. These sites will require much more robust management controls.

4.2 Transfer of odorous chemicals to air

You can control many odorous chemicals (at least partly) by reducing their rate of evaporation. The methods to do so can be either chemical or physical. You can, for example:

- lower the temperature by avoiding direct sunlight or otherwise reducing the water evaporation rate and the release of dissolved odorous chemicals;
- increase humidity in the immediate environment to reduce evaporation, as above;
- reduce airflow over the surface of odour-releasing materials to reduce the rate of evaporation;
- control the acidity/alkalinity of a material to make specific smelly chemicals much more soluble in water and less likely to evaporate, for example, acidic conditions (low pH) can suppress the evaporation of alkaline chemicals such as ammonia. Conversely, alkaline conditions (high pH) can suppress odorous acidic chemicals such as propionic acid or acetic acid;
- introduce temporary surface treatments to lower the surface temperature or create a chemical barrier. Plain water is the simplest and is often helpful; these treatments can also contain pH buffers as above or other chemicals to make odorous chemicals more soluble. You should carefully assess any commercial treatments that claim to suppress or break down odorous chemicals - one study found no relationship between the cost of commercial surface treatment products and how well they work;
- reduce the surface area of an odorous material; this will cut the rate of evaporation;
- avoid disruptive activities such as shredding or screening, which dramatically increase exposed surface area and emissions, unless adequate containment is provided.

4.3 Containment of contaminated air

If you cannot avoid producing significant levels of odorous air, you will need to contain the emissions before treating them.

- Choose containment and treatment methods together so that you can coordinate the most appropriate treatment with management of ventilation rates.
- Localised containment lowers the volume of air required to be treated. It will normally be much more cost effective than if you rely entirely on a large building for primary containment.

- Where you are relying on containment to control continuous odour you should maintain effective airflow by pressure control within the process plant or within process buildings. 'Air-lock' entry and exit doors will enable the integrity to be maintained. Complex air management systems which are affected by thermal lofting or complex ducting arrangements will need to be designed by competent engineers.
- Keep windows and doors on buildings used for containment shut. Pedestrian doors should be self-closing.
- Be aware that two openings on either side of a building can create a through-draft and carry odours out.
- Consider all of the normal techniques for minimising VOC emissions from tanks and pipework (see the section on fugitive emissions in *How to Comply with your Permit*).
- Check pipes, valves and tanks regularly for leaks and damage.

In some cases air tight containment measures, such as pressure vessels in an anaerobic digestion plant, will not require ventilation at all except to transfer gasses produced to an engine. Any venting via a relief vale should be considered as an emergency and investigated and managed to prevent recurrence.

4.4 End of pipe treatment

There are many ways to treat air from contained sources. They are, in general, the same techniques used for chemical abatement:

- adsorption using activated carbon, zeolite, alumina (disposable or with regeneration);
- dry chemical scrubbing - solid phase impregnated with chemical agents such as pH modifiers, chlorine dioxide or permanganate;
- biological treatment – trickling biofilters, soil bed biofilters, non-soil biofilters – (peat, heather, wood bark, compost), bioscrubbers;
- absorption (scrubbing) - spray and packed towers, plate absorbers (single pass or recirculating);
- thermal treatment - existing boiler plant, thermal or catalytic oxidation;
- other techniques – odour treatment chemicals, condensation, plasma technology (ozone), catalytic iron filters and UV.

A number of sources of information on such techniques are suggested in the Bibliography.

It is very common to use hybrid or combined methods. For example, many activated carbon products are impregnated with dry chemical scrubbing reagents and ozone methods sometimes work best after excess moisture have been reduced by condensation.

As with containment, it is typically cheaper and more effective to treat small quantities of highly odorous air than it is to treat large volumes of less odorous air.

If a site has two odorous exhaust streams with very different chemical characteristics, it is often cheaper and more effective to treat them separately.

Biofilters need careful and expert maintenance of their microbial health to maintain their effectiveness.

You may find opportunities for abatement in existing plant and materials. Combustion plants such as boilers or compost heaps, for example, can often treat low-volume high-odour

streams. They can do this either on their own, as a primary treatment before a polishing step, or before enhanced dispersion through an elevated stack.

Some processes are very dusty, and odour may be associated with the dust. Examples include some pharmaceutical processes, poultry farms and animal feed mills. You might be able to reduce odour by filtering out the dust or using mist eliminators for droplets. Some forms of abatement equipment will need preliminary particulate control. Packed bed scrubbers, for example, will need protection. You may be able to recycle the collected particulate matter, particularly if it has some value.

Proprietary odour treatment chemicals can be effective within a process or abatement chamber where effective mixing can take place. They may also work within a building such as a waste reception hall or on in a farm building where there is sufficient time for mixing to occur. These products may chemically react with the odorous components to remove them or convert them to less odorous compounds that have a lower hedonic score and are therefore less offensive. In ambient air they are less effective as there is very limited control over mixing. Nevertheless they can be beneficial in some situations. Simple water misting, surfactants or buffers may be as effective as more complex agents. Masking agents which inhibit the recipients sense of smell should not be used. Perfumes are often perceived as offensive as the original odour and are simply adding another pollutant to the air.

4.5 Transport and dispersion

High stacks may be used to allow odorous emissions to disperse before they reach the ground. Similarly, where it is possible to increase the physical distance to receptors, this can also reduce exposure. Dispersion modelling (Appendix 4) can be used to assess the benefits of these measures. Where feasible, some dispersion benefits may be realised through arranging emissions points at locations which are further away from nearby receptors.

You may be able to avoid peak impacts by timing your operations. For example, suspending operations when there are inversion or cold drainage flow conditions or when the wind direction is towards nearby residents, or by undertaking activities at a time of day when residents are not present or are likely to be indoors. Where this is part of your control strategy you should be monitoring weather and forecasts so that you are ready to take swift action to avoid problems.

4.6 Engaging your neighbours

It is really important for you to engage with the people who may be affected by your activities. Many operators do this as a matter of course and have well-established procedures for interfacing with the general public. However, some operators overlook this essential step.

Your neighbours are likely to perceive odours from your site quite differently from you or your employees. For your neighbours, odours may:

- cause annoyance;
- reduce enjoyment of home and gardens;
- reduce property values;
- raise concerns about exposure to harmful emissions (e.g. bio aerosols);

- cause them to view your facility as a liability to the community, rather than an asset.

Engaging with, and becoming an active member of, the local community may enable operators to mitigate the impact of their activities and increase tolerance of odours, particularly where those odours are relatively transient.

Engagement can include a wide variety of activities, but communication is always a key aspect. This means being a reliable source of information to the community and being available to hear what they have to say. Exactly how you establish channels of communication depends upon what you and the community are comfortable with.

Active participation in the community not only helps people to get to know you and your staff, but also helps people to understand what you do and, possibly, even view you as an asset. Some of your employees may live in the surrounding community and can be important as ambassadors for your business.

4.7 Responding to complaints

Your odour management plan should show how you respond to complaints.

You should investigate any complaints promptly and take appropriate remedial action. You should tell the complainant and any one else likely to have been affected by what you have done. You should record the details of the complaint and the actions you have taken. An example of complaint recording is given in Appendix 1.

If you need to substantiate the odour, a record form and advice for sniff testing are also given in Appendix 1. However, if you and your staff have become accustomed to the odour through exposure the results may be unreliable. (see adaptation in Appendix 2).

When investigating a complaint you should work through the following questions:

- Is the process under control? (Have you received exceptionally odorous wastes? Has a normally aerobic composting activity become anaerobic? Have putrescible wastes been left standing for too long before processing?)
- Have odour containment measures failed? (Has a door been left open? Have odorous materials been stored outside a containment area? Have adverse conditions, such as weather, overwhelmed containment structures?)
- Have treatment measures failed? (Has a carbon scrubber become saturated? Has a biofilter been temporarily overloaded? Does a wet scrubber need maintenance?)
- Have dispersion methods failed? (Have stable atmospheric conditions failed to disperse an odorous plume? Have your neighbours been exposed to emissions because of unfavourable night-time cold drainage flow conditions?)
- If the odour is associated with hazards, such as treatment of hazardous materials, is there any possibility of health risk to the local community?

You should keep auditable records of any investigations you carry out. These records will be invaluable to you in analysing incidents and stopping them from happening again. They may in any event be required as part of your OMP or permit conditions.

4.8 Ceasing or reducing operations

Sometimes, your investigation will show that you need to stop some activities immediately or take some other remedial action. You should be ready for this. Plan effective and proportionate remedial measures and develop contingency plans to apply them. If you think that a particular activity will cause odour problems, then in most cases you should suspend that activity until effective controls are in place. The main exceptions to this would be when to stop one activity would cause even greater odour problems e.g. delaying turning a composting windrow may make anaerobic conditions worse, or where to cease operating immediately would give rise to health or welfare issues e.g. in the intensive farming sector.

4.9 Actions when problems arise – your accident management plan

Your permit may require you to maintain an accident management plan in which you may choose to address odour-related accidents. If you also have an OMP it may be more appropriate to cover odour-related accidents in that document, identifying the appropriate response to a situation and who is responsible for taking preventative action after an incident.

5 Monitoring

You need to assess your odorous substances emissions so that you can work out how effective your control measures are. What you do in terms of monitoring will need to reflect the actual or potential impact on the local community. The following includes a brief overview of available monitoring methods and their applicability.

5.1 Your monitoring plan

You should be clear about reasons for monitoring in order to identify how best to carry it out. You may want, for example, to:

- assess impact (using complaints, community questionnaires, interviews and field sniff testing);
- assess exposure (using field surveys, field dilution olfactometry, surrogate monitoring);
- investigate sources and pathways (using fence line monitoring, meteorological monitoring);
- measure releases (using dynamic dilution olfactometry, surrogate monitoring, assessment against emission limit values);
- control processes (using temperature, oxygen levels, pH, moisture).

Monitoring can take several different forms:

- sniff testing (to check ambient air on or off site);
- meteorological monitoring - very simple, low risk, sites may get away with 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. H2S, ammonia, odourless methane as an indicator of odorous landfill gas etc, pH and flow in a scrubber);
- emissions monitoring if there is a point of discharge;
- grab samples of source emissions that are subsequently diluted to the odour threshold in a laboratory setting (i.e. BSEN 13725 Dynamic Dilution Olfactometry); ports may be necessary in order to obtain representative samples from stacks but these ports should never be used directly for sniffing unless the odour levels are moderate and the stack is known to contain healthy, breathable air.

Your monitoring plan should include:

- why and how monitoring will take place, for example:
  - steady state monitoring to confirm that odour is under control – regular sniff tests and if appropriate, continuous monitors or process surrogates;
  - assessment against any emissions limits in your permit or OMP;
  - if an odour problem arises, the monitoring you will carry out to establish what needs to be done;

    - if you have put a solution in place, the monitoring that you will do to confirm that it has resolved the problem;
- how to interpret the results including, whenever feasible, trigger values for further monitoring or remedial action;
- if the terrain is complex, or if odours come from many places, how monitoring will handle this;
- record-keeping and reporting.

5.2 Issues to take into account in any ambient air monitoring

Whether using sniff testing or taking samples you should take account of the points set out below.

- It is often difficult for investigators to witness odour incidents that are episodic and short-lived.
- Emissions are greatly diluted from their point of release, and are often below detection limits of instruments but can still be detected by people.
- Peaks in exposure may be due to changing dispersion conditions (wind direction, turbulence) or variable emissions (doors opened).
- Emissions from elevated stacks may reach the ground beyond the monitoring point.
- It can be difficult to work out where an emission comes from or to distinguish it from other sources.

While chemical detection can be improved by sampling more air and concentrating this on a sorption device, this only provides average concentrations. These bear little relevance to the peak events that can cause annoyance / offence etc. The variable nature of many odour exposure scenarios and the short term of some sampling methods mean that it is much easier to demonstrate exposure than to conclude that no exposure has taken place.

5.3 Complaints monitoring

Complaints are a direct indication that odours may be causing pollution. Accordingly, responding to them is an important aspect of site management, as described in Section 4.7 above.

As with other aspects of a monitoring strategy, thought should be given to how this information is gathered, managed and understood. The best approach to take will be influenced by the nature of complaints as well as fundamental characteristics of our sense of smell. Further discussion on the sense of smell and annoyance can be found in Appendix 2 and several related references in the bibliography. The following points should be noted when assessing complaints information:

- Operators may receive complaints directly from community members, or indirectly from the Environment Agency or a Local Authority.
- Complaints may be received immediately following an odour incident, or some time later.
- Community members may have concerns about other issues such as flies, dust and noise. Complaints may therefore relate to more than just odour.

- Odours may cause people to become concerned about the potential for exposure to harmful emissions such as chemicals or bio-aerosols. These concerns may be amplified where they or their family members have health problems.
- It is normal for odours to cause an emotional response.
- People can usually give a good account of their experience of odour. However, depending upon the number and type of odour sources in the area, they may or may not be able to correctly identify the source.
- With practice, most people have an inherent ability to recognise a very large number of individual odours. However, the experiences and descriptions of specific odours may vary considerably from one person to another
- Most people have a very limited vocabulary to describe odours.

Consideration also needs to be given to how odour complaints can be used to assess the magnitude of odour exposure and annoyance in the community. Such an assessment is complicated on the one hand by factors which may suggest an overestimate of annoyance, and on other factors which will suppress complaints, for example:

- complaints may be partly motivated by other issues such as litigation or neighbour disputes about other issues;
- there may be concerns about other pollutants such as flies, dust or noise;
- people may not know who to complain to;
- people may be concerned about the potential for retaliation, labelling, reduced house prices or other adverse consequences arising from complaints;
- there may be a perception that nothing will be done about the complaint.

A complaints monitoring strategy should therefore seek to include an understanding of those factors which might lead to an over or underestimate of impact and seek to reduce these influences wherever possible. For example, community outreach activities can help to overcome some of the factors which inhibit complaints and foster good community relations thereby resulting in complaints records which more accurately reflect odour pollution impacts. To the extent these influences cannot be completely removed, efforts should be made to understand them and take them into account.

If operators feel that complaints are motivated by issues other than odour concerns then they should raise this with the local Agency officer.

5.4 Sniff testing

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 given in Appendix 1.

Never put yourself or others at risk by attempting to sniff potentially hazardous emissions and always be mindful of physical hazards associated with sniff testing locations.

Self-monitoring by operators using this method may not be ideal because staff working at the site get used to (i.e. they adapt to) odours from the site and this adaptation means that they may not be able to assess the level of odour objectively. More information on adaptation

can be found in Appendix 3. You should therefore consider using independent contractors or even members of the community.

The points in Section 5.2 also need to be taken into account.

More objectivity may sometimes be brought to sniff testing by the use of aids such as a field dilution olfactometer. The only device currently available is the Nasal Ranger. This device can assist investigators in assessing the concentration of odours in ambient air. The investigator breathes filtered air through the device while they manually adjust the amount of unfiltered ambient air until the odour is just detectable. This results in a crude field measurement of odour concentration in dilutions to threshold. Some authorities use detection requiring more than 7x dilution to indicate unacceptable exposure. Our view is that this may prove to be useful evidence when assessing how much pollution there is – see Step 1 in Section 3.

Such instruments will be subject to some of the same limitations as sniff testing:

- olfactory sensitivity of the user;
- short term adaptation;
- the need for the tester to be physically present during peak exposures;
- requires good usage technique;
- rapidly fluctuating odours may change in the time it takes to carry out the assessment;
- users distracted by what is happening around them can sometimes not detect even a strong smell.

Nevertheless, when used appropriately by competent individuals, the method can provide more objective results which tend to underestimate the actual exposure. This tendency to underestimate means that results should normally be interpreted as a minimum odour concentration level.

5.5 Odour diaries and community surveys

You may recruit community members to take part in monitoring. Designated residents could, for example, do walk-over surveys (offsite), either on a regular basis or in response to complaints. Community surveys can give you a useful snapshot of the level of odour annoyance. Open surveys, where you make it clear what you are trying to achieve, are easier to design. The responses you get may, though, be vulnerable to bias. It is more difficult and expensive to design and carry out disguised surveys (in which you try to gather information about odour impact indirectly). A considerable amount of planning needs to go into any survey. You need to make sure that the individuals and companies who carry out your surveys are competent to do so, so that there's as little bias as possible in the results.

Members of the community could also keep odour diaries (Example templates for odour diaries and other useful forms are given in Appendix 1). You could ask key individuals, in strategic locations in the community to keep a diary of times and dates when they detect smells, to start building up a pattern of odour problems over time, which can then be associated with other factors such as wind direction and site activities. You shouldn't expect individuals to keep such records for a long time. And if you don't do anything to improve things, reporting rates will usually fall. But if you ask for and act upon information, you can improve your relations with key members of the community and have less of an impact on everyone else.

You should keep complete and accurate records of any such monitoring.

Community members who gather information on odour may wish to remain anonymous. Where people are identified the data is more useful but you must comply with the Data Protection Act, 1998. In particular, you must tell people what the information will be used for and to whom it may be sent. You can find more details on how to comply with the Data Protection Act, 1998 on the Information Commissioner (ICO) website http://www.ico.gov.uk.

5.6 Grab samples and dilution olfactometry

Dynamic Dilution Olfactometry: The standard method for measuring odour in Europe is Dynamic Dilution Olfactometry (BS EN 13725:2003). This involves diluting a grab sample in the laboratory to a point where each member of the panel can just begin to detect the odour. The result is the number of dilutions used when half of the panel can detect the odour. So a dilution detection level of 10,000:1 would be a concentration of 10,000 odour units m^3 (ouE/m^3) (1ouE m^3 = the level of detection under laboratory conditions). This method is only suitable for concentrated samples, collected at source, which are relatively stable. If you are testing highly variable emission sources, you will need to ensure that representative samples are taken. The BS standard 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 3 samples are typically required to assess the variability of results.

Olfactometry (BS EN 13725:2003) is not suitable for measuring odours in an ambient context. VDI 3940 defines methods by which odour exposure can be measured directly in the field. A working group CEN WG64/TC27 is currently developing European standard methods for assessing long term odour exposure in the field, based on the grid method described in VDI / DIN 3940.

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.

Taking samples

Many odorous chemicals stick to or react with their surroundings. So you should use non-stick, inert sample containers as suggested in BSEN13725. (e.g. silica-lined steel canisters, Tedlar bags, etc.). Using the lung principle avoids the degradation of sample in the pump.

You won't be able to measure odorous chemicals that dissolve into the water phase in a sample therefore you need to take steps to avoid condensation. The BSEN13725 standard covers sampling requirements.

5.7 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. Landfill gas emissions are dominated by

methane. So the instrument can often still provide a good measure of methane and, by association, odour. It may also be useful for detecting fugitive emissions – see below.

- Long path-length monitoring (e.g. LIDAR) also just measures Volatile Organic Compounds (VOCs). It can, though, be useful for detecting odour sources because it allows you to 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 (e.g. Jerome 631X) can measure extremely low levels of H_2S (ppb range). But they may 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 so that the results may not be representative of the odour.
- Electrochemical detectors (electronic noses) used in arrays can be useful to detect a change of state in operating conditions as process controls. They are unlikely to be of value in measuring exposure in ambient air.

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 is particularly a problem for chemical analysis of highly odorous chemicals in ambient air where the human nose may be more sensitive than any analytical instruments.

5.8 Measuring odour surrogates and process controls

In a few cases, you will be able 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 anaerobic conditions in a composting windrow, can be good indications of whether the 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. The issues associated with the Jerome instrument above is a good example of this.

Most of the chemical instrumentation listed above can be used as surrogates – that is they may be measuring a single substance which is not actually the odorous chemical but is present in a constant relationship to it.

5.9 Fugitive emissions

Finding fugitive (including diffuse) emissions can sometimes be quite straightforward, be it open doors on a waste plant or the spreading of manure on farm land. But it is important that you don't focus only on sources that are easy to identify and measure. Don't ignore sources that are less obvious, episodic or otherwise inconvenient. Looking for fugitive emissions in a complex process (e.g. a refinery or chemical plant) requires a detailed knowledge of valves, flanges and vents, what processes are taking place and what substances are where.

A flame ionisation instrument provides instant readings of hydrocarbons and may be useful in specific cases. These are where there are significant releases of hydrocarbons, they can be associated with odorous emissions and there are no other significant sources of hydrocarbons. You should also consider safety and other practical issues when monitoring. For example, you probably wouldn't undertake a leak survey outside when it was windy. Also, if your survey reveals a leaky valve, for example, you don't need to quantify the leak – you should just fix it.

If you do need to measure odour concentration, then use a grab sample, followed by dilution olfactometry. Grab samples will only be suitable for relatively stagnant or stable air conditions, such as from a stack, enclosed room or flux box.

Flux boxes quantify fugitive odour emissions from a surface such as a windrow or pond. A number of variations are possible. Flux boxes can be open, sealed or purged. The surface area covered can also vary. There are significant issues to be aware of such as whether the presence of the box will significantly affect emissions. Area emissions are usually inconsistent across an emitting surface and over time. For example, emissions between the top and the bottom of a windrow may differ. Also, fugitive emissions from a landfill may increase when the barometric pressure is falling, or when there are technical difficulties with the landfill gas extraction system. Emissions measured over time won't give the peak emission rates that we usually look for in odour investigations.

You can find an example of using flux boxes to assess surface emissions in the Environment Agency Guidance LFTGN 07, *Guidance on Monitoring Landfill Gas Surface Emissions*. As always, the limitations have to be understood and the results need to be carefully interpreted.

Tracer gas techniques may be useful when assessing the integrity of containment features such as tanks or buildings. The Environment Agency does not promote or condone the use of SF6 for this purpose as it is an extremely potent greenhouse gas.

5.10 Monitoring records

Whatever monitoring you undertake, your records need to include enough information about the emissions measurement for you to use that data in your analysis. For example, results for a grab sample analysed by laboratory-based olfactometry must, include:

- date, time and details of emissions point sampled, and why you chose them;
- how you preserved the samples (condensation, holding time and conditions);
- method of sampling (e.g. stack sampling through a 3 metre stainless sampling tube);
- the laboratory where the results were analysed, and any certification status;
- any laboratory observations that might affect how you interpret results;
- process parameters;
- weather conditions.

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Appendix 1 – Forms

This appendix provides examples of a report form for sniff testing, a complaint form and an odour diary. Word versions of these are available[11].

Odour reporting form (sniff testing)

You may need to carry out an assessment either to work out whether you are complying with your permit, or as a part of an investigation into a complaint.

You can use routine assessments to build up a picture of the impact the odour has on the surrounding environment over time. You can develop 'worst case' scenarios by doing assessments during adverse weather conditions or during particularly odorous cycles of an operation. Ideally, you should use the same methodology to follow up complaints.

Please note:

- Staff normally exposed to the odours may not be able to detect or reasonably judge the intensity of odours off-site. You might be better off using office staff or people who have not recently been working on the site to do this.
- Anyone who has a cold, sinusitis or a sore throat, is likely to underestimate the odours.
- To improve (or to check) data quality, you can get two people to do the test independently at the same time.
- Those doing the assessment should avoid strong food or drinks, including coffee, for at least half an hour beforehand. They should also avoid strongly scented toiletries and deodorisers in the vehicle used during the assessment.

Where you test will depend on:

- whether you are responding to a complaint;
- whether you are checking your state of compliance at sensitive receptors;
- whether you are trying to establish the source of an odour;
- wind direction.

The assessment may involve someone walking along a route that you have selected either because of these factors, or in response to the conditions they found when they got there. Another option is to choose fixed points so that you can evaluate the changing situation over several weeks or months. Or the test points may vary from test to test according to local conditions, which would help you identify worst case conditions.

You should also keep a note of any external activities (such as agricultural practices) that could be either be the source of the odour, contribute to the odour, or be a confounding factor. Remember that an odour will become diluted and may change character as this happens.

You should also take the factors given in Section 5.2 Monitoring – Ambient Air into account.

[11] Via EPR guidance at http://www.environment-agency.gov.uk/business/topics/permitting/36414.aspx#Horizontal_guidance

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Odour report form				Date	
Time of test					
Location of test e.g. street name etc					
Weather conditions (dry, rain, fog, snow etc):					
Temperature (very warm, warm, mild, cold, or degrees if known)					
Wind strength (none, light, steady, strong, gusting) Use Beaufort scale if known					
Wind direction (e.g. from NE)					
Intensity (see below)					
Duration (of test)					
Constant or intermittent in this period or persistence					
What does it smell like?					
Receptor sensitivity (see below)					
Is the source evident?					
Any other comments or observations					

Sketch a plan of where the tests were taken, the potential source(s).

Intensity		**Receptor sensitivity**
0 No odour	4 Strong odour	Low (e.g footpath, road)
1 Very faint odour	5 Very strong odour	Medium (e.g. industrial or commercial workplaces)
2 Faint odour	6 Extremely strong odour	High (e.g. housing, pub/hotel etc)
3 Distinct odour	Ref: German Standard VDI 3882, Part 14	

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Odour Complaint Report Form	
Time and date of complaint:	Name and address of complainant:
Telephone number of complainant:	

Date of odour:	
Time of odour:	
Location of odour, if not at above address:	
Weather conditions (i.e., dry, rain, fog, snow):	
Temperature (very warm, warm, mild, cold or degrees if known):	
Wind strength (none, light, steady, strong, gusting):	
Wind direction (eg from NE):	
Complainant's description of odour: o What does it smell like?	
o Intensity (see below):	
o Duration (time):	
o Constant or intermittent in this period:	
o Does the complainant have any other comments about the odour?	
Are there any other complaints relating to the installation, or to that location? (either previously or relating to the same exposure):	
Any other relevant information:	
Do you accept that odour likely to be from your activities?	
What was happening on site at the time the odour occurred?	
Operating conditions at time the odour occurred (eg flow rate, pressure at inlet and pressure at outlet):	
Actions taken:	

Form completed by:	Date	Signed

Intensity

0 No odour
1 Very faint odour
2 Faint odour
3 Distinct odour
4 Strong odour
5 Very strong odour
6 Extremely strong odour

Odour Diary					Form version 110319	Sheet No
Name: Telephone Number:	Address:					
Date of odour:						
Time of odour:						
Location of odour, if not at above address (indoors, outside):						
Weather conditions (dry, rain, fog, snow etc):						
Temperature (very warm, warm, mild, cold or degrees if known):						
Wind strength (none, light, steady, strong, gusting):						
Wind direction (eg from NE):						
What does it smell like? How unpleasant is it? Do you consider this smell offensive?						
Intensity – How strong was it? (see below 1-5):						
How long did go on for? (time):						
Was it constant or intermittent in this period:						
What do believe the source/cause to be?						
Any actions taken or other comments:						

Intensity

0 No odour
1 Very faint odour
2 Faint odour
3 Distinct odour
4 Strong odour
5 Very strong odour
6 Extremely strong odour

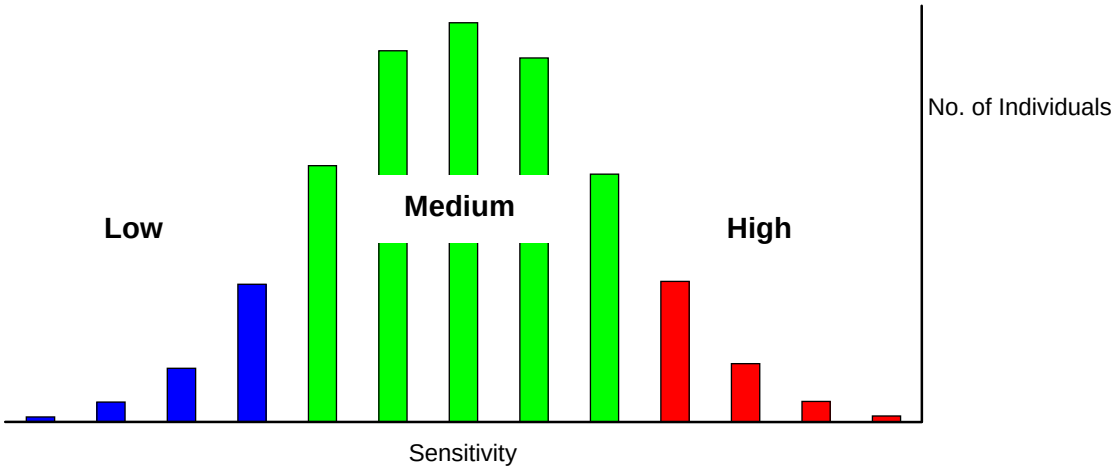
Appendix 2 – Important odour information

The information in this appendix is intended to help you understand odour issues and terms. It is also intended to be useful background for modelling exposure as described in Appendix 3.

Odour detection thresholds and odour units

Within any group of people, odour detection thresholds will vary widely. This variation between people with a healthy sense of smell across a community correlates well with the distribution shown in Figure A2.1.

Figure A2.1: Normal range of odour sensitivities



Odour detection threshold values for individual chemicals are based on the concentration at which half of a test group can just detect the odour. That is, half of the population should detect the odour, while the other half does not. Published values may vary widely and should be used with caution.

Recognition thresholds and annoyance / nuisance etc benchmarks are expressed as multiples of the odour threshold concentration.

An **odour unit** is a measure of the concentration of a mixture of odorous compounds. It is determined by means of olfactometry.

Odour unit values are determined by a standard method given in BSEN13725; 2003 on olfactometry. An odour unit as defined by the CEN standard is 1 ou_E. (European Odour Unit)

1 ou_E/m^3 is the point of detection.

A rapidly fluctuating odour is often more noticeable than a steady background odour at a low concentration. People can detect and respond to odour exposure that lasts as little as one or two seconds.

Hedonic scores

The measurement scale for hedonic tones typically ranges from +4 for very pleasant odours (bakeries, say) to -4 for foul ones (rotting flesh, for example). Neutral odours score 0 This score refers to the type of smell, irrespective of its strength (intensity) and can help to decide how offensive an odour may be.

Table A2.1: Hedonic scores for everyday odours[12]

Description	Hedonic Score
Bakery (fresh bread)	3.53
Coffee	2.33
Hay	1.31
Raw potato	0.26
Rope (hemp)	-0.16
Kippery-smoked fish	-0.69
Paint	-0.75
Mothballs	-1.25
Disinfectant, fresh tar	-1.60
Wet wool, wet dog	-2.28

Raw potato is about neutral. Even smells that most people describe as positive and delicious (such as fried chicken or baking bread) can become annoying to anyone subjected to them continuously.

The hedonic score of an emission may be altered by various treatment methods that chemically change some components to less odorous compounds. Odour neutralising compounds can work in this way. It may be possible to achieve this at source for example by dosing the fluid in an odorous sewer.

Adaptation

Adaptation to odours varies with the odour. People can adapt to individual odours within fractions of a second. Adaptation also happens in proportion to both the intensity of the odour and how long someone is exposed to it. The person will begin to recover when they're no longer exposed to the odour, or when it is reduced. Both adaptation and recovery tend to occur rapidly at first, then more slowly as time goes on.

Ground level emissions are dispersed in turbulent air. Concentrations of the odour can vary widely from second to second. As a result, adaptation does not occur. Your neighbour, that is, continues to be annoyed about it. Meanwhile your staff, who are constantly exposed to the odour inside the building, become immune to it.

Long-term adaptation can happen when people are exposed to high levels of specific odours for a long time. Receptor epithelial cells are normally replaced every 30 to 40 days. It can take healthy individuals, therefore, this long to regain their sense of smell in these circumstances.

Some chemicals, such as ammonia, result in far less adaptation. People will detect the emissions for as long as they are exposed to them.

The relevance of adaptation is described in the context of monitoring in Section 5.4 - Sniff testing.

[12] Dravnieks A, Masurat T, Lamm R A, "Hedonics of Odours and Odour Descriptors": in Journal of the Air Pollution Control Association, July 1984, Vol. 34 No. 7, pp 752-755

A suggested table for characterising odour sources

Surveying a complex site for odour requires a thorough understanding of what is going on at the site, and of what odorous materials are held or processed there. The table below may help you compile information on odour sources.

Table A3.2 Odour sources

Parameter	Example entries
Source description	Composting feedstock pile
Odorous materials	Source segregated green and kitchen waste from households, bi-weekly collection
Containment / release point	Open air surface of the pile. Inside a process building, but with no effective odour containment.
Odour description	Variable depending upon feedstock makeup and condition. May include a strong component of rotting food.
Intensity at or near the point of release (0 not detected to 6 extremely strong)	Difficult to characterise if the source is within a process building. Initially quite intense but the perception rapidly diminishes upon exposure. It may not be possible to distinguish from other sources within the process building. The intensity scale is taken from VDI 3882 Part 1.
Pattern of release	Expected to peak during waste receipt and other waste movement activities. Material is normally processed daily so that no waste would be left overnight.
Potential for problems	Equipment failures or excessive waste inputs may result in extended holding times for feedstock materials. In bad weather, waste may arrive wet, with anaerobic decay already advanced.

Cold drainage flow

Cold drainage flow occurs on clear, still nights, when cooled air flows downhill. This night-time surface cooling is what sometimes causes ground frost when ambient air temperatures remain above freezing. Cold drainage can result in localised ground frost conditions which follow low lying flow paths.

The flow of surface cooled air can happen on smooth slopes above about one degree through to rough slopes above five degrees. Drainage flow speeds are typically one or two metres per second. This can concentrate odour in low-lying places.

This phenomenon will only apply to ground level sources. Stack releases will typically be well above the layer of cold air stratification. We are not aware of any readily available modelling packages that might help quantitatively anticipate the impact of cold drainage.

A general awareness of this phenomenon may, though, help explain peculiar patterns of complaint or suggest what further investigations you might need.

In some countries, wind machines are routinely used to protect crops by disturbing the cold air near the ground and mixing it with warmer air at higher levels. Theoretically this method or barriers, such as low lying dense vegetation, may help to manage the flow of cold odorous air at ground level under cold drainage conditions. The application of these longstanding agricultural methods to odour dispersion is unproven.

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Appendix 3 – Modelling odour exposure

Modelling be a useful source of predictive information to assess the likely impact of odour. It is important to give evidence from all predictive methods appropriate weight depending upon their relevance and reliability in the circumstances of a particular site. A detailed discussion of how to model exposure is beyond the scope of this guidance. Odour modelling is specialised enough that only those who have a good technical understanding of modelling methods and who are familiar with the requirements of the Environment Agency should do it. They will be able to highlight the inherent uncertainties.

The modelling method commonly used in the UK calculates a 98th percentile of hourly average odour concentrations over a year. The results are expressed as odour unit contours on a map. You can check unacceptable levels of odour pollution against exposure benchmarks. When the results are presented and interpreted, they must take uncertainty into account, especially in terms of emissions and weather data.

You can use modelling to:

- predict the impact of a new proposal, comparing with benchmarks;
- as a tool to assist in the investigation of the cause of odour complaints from existing facilities and the influence of changing weather conditions on odour dispersion;
- compare the cost effectiveness of odour mitigation options;
- work out emission limits for point source emissions, either mg/m^3 for a single odorous substance or ou_E/m^3 for mixtures of substances - we don't use exposure values at receptors in your permit because they are almost impossible to measure; in the rare occasions that they are used, modelling first converts them to emission rates from the point source - we can then use stack monitoring to check compliance;
- indicate how much improvement is needed or size abatement equipment;
- calculate a suitable chimney height to provide an acceptable exposure at receptors.

However, there may be much greater uncertainties associated with odour modelling than with the modelling of other pollutants for the following reasons:

- The human nose responds to odour exposure over a 1 to 5 second interval. Average exposure levels may very well be below the detection threshold but still expose people to short term concentrations which are much higher. See Appendix 2).
- UK odour benchmark levels are based on research at one particular type of site under distinct dispersion conditions (e.g. ground level emissions in generally flat terrain).

Some of these uncertainties are discussed in detail in Science Report: SC030170/SR3, Review of Dispersion Modelling for Odour Predictions See Bibliography.

Benchmark levels

The benchmarks are based on the 98th percentile of hourly average concentrations of odour modelled over a year at the site/installation boundary. The benchmarks are:

- 1.5 odour units for **most offensive** odours;
- 3 odour units for **moderately offensive** odours;

- 6 odour units for **less offensive** odours.

Any modelled results that project exposures above these benchmark levels, after taking uncertainty into account, indicates the likelihood of unacceptable odour pollution. You should also take evidence from other assessment methods and site specific influences into account when drawing final conclusions.

Referring to Figure 1, these benchmarks represent the intersection of the red and amber zones. It is still necessary to use appropriate measures/BAT to ensure that odour is minimised in the amber zone. Where a result is close to the benchmark it suggests that more is likely to have be done to minimise odours in the amber zone.

Local factors may influence these benchmarks. For example if the local population has already become sensitised, it may be prudent to reduce the benchmark by say 0.5. If there are short or infrequent episodes of very high odours that are averaged out by the modelling, they would need to be considered separately.

The following are indicative examples only and do not have definite cut-off points in terms of the industry types listed. Although this ranking is based upon the views of a number of people, there may be individuals who respond differently. It should be noted that:

- it is the odour that matters not the activity;
- this assumes the unmodified odour – the character or offensiveness may be changed by changing the hedonic score for example by excluding difficult wastes from a landfill, by pre-treating sludge or by adding a modifying chemical to an odorous air stream;
- odours from processes likely to become anaerobic or septic are more offensive;
- abatement i.e. reducing the amount of the odorous chemicals released does not change this score, rather, abatement should enable the operator to meet these benchmarks;
- the character of odours from different parts of a process may differ – for example it may only be the sludge handling part of a sewage works that attracts the highest score;
- the character of an odour can sometimes change with distance;
- Offensiveness also takes into account the sensitivity of the receptor. These figures are primarily for sensitive receptors such as housing.

Most offensive

- processes involving decaying animal or fish remains
- processes involving septic effluent or sludge
- biological landfill odours

Moderately offensive

- intensive livestock rearing
- fat frying (food processing)
- sugar beet processing
- well aerated green waste composting

Most odours from the processes we regulate fall into this category i.e. any odours which do not obviously fall within the “more offensive” or “less offensive” categories

Less offensive

- brewery
- confectionery
- coffee roasting
- bakery

Odour modelling requires good quality assessments of emissions rates (source terms). Where emissions are inconsistent or are released from non-point sources, these emission rates can be difficult to assess.

The World Health Organisation[13] (WHO 2000) has produced guideline values for the avoidance of substantial annoyance for a few single substances as surrogates for overall odours from specific sources, namely carbon disulphide in viscose emissions, hydrogen sulphide, styrene, tetrachloroethylene, toluene. You may find these useful as part of a wider assessment but the values should be used with caution as they are based on a different averaging method and a different assessment of what is acceptable.

On rare occasions when modelling the odour impact of a single substance you may be able to find detection thresholds which have been determined by experimentation. Sources of these threshold values may differ and you should justify the value you decide to use. Then with a knowledge of whether specific chemicals would be considered highly, moderately or less offensive, a benchmark concentration can be calculated for these also. So, for example, methyl methacrylate has a reported detection threshold of 0.38mg/m^3. It is highly offensive and so it should be modelled to 1.5 odour units (see above). Since 1 odour unit is the detection threshold, the equivalent concentration is 1.5 x 0.38 = 0.57mg/m^3

The Agency does not favour or prescribe the use of any particular dispersion model. It is left to operators/applicants to justify their choice of model (including the version). However the chosen model (and specific version) has to be fit for purpose and based on established scientific principles. It also needs to have been validated and independently reviewed. For the purpose of transparency, the Agency expects full technical specifications, validation and review documents of the chosen model (and the specific version) to be publicly available.

There are two types of dispersion models that meet these requirements and can currently be used to predict a map of the odour concentration frequency caused by odour emissions:

1. Steady state Gaussian models (e.g. Aermod, ADMS). These general-purpose models are well established and routinely applied for odour assessments, and represent a good mathematical approximation of odour plume behaviour when the

[13] WHO (1987). *Air quality guidelines for Europe.* Copenhagen, World Health Organisation Regional Office for Europe, 1987 (WHO Regional Publications, European Series No. 23).

odour source is located in relatively simple terrain; where the winds are relatively evenly distributed; and where the frequency of low wind speeds (< approx 1.5 m/s) is below 2% for each compass direction.

2. Non-steady state Lagrangian models (e.g. Calpuff and the German regulatory model Austal). Also known as 'puff' models. These models are increasingly being used for odour assessments purposes and are capable of simulating a wider range of dispersal conditions than steady state models (e.g. valley channelling, cold drainage, coastal effects, stagnation, high percentage of low wind speeds or calms). They are therefore useful for odour assessments at sites which are characterised by such complex air flow/dispersion conditions.

Non-steady state modelling continues to develop and where an operator wishes to use such models they should seek the advice of the Environment Agency for the latest position.

Irrespective of the model applied, sufficient information should be supplied to enable the model to be audited.

A sensitivity analysis, to enable the overall uncertainties to be understood, should also be provided including:

- likely uncertainties in the source term, including a consideration of fugitive emissions;
- the degree to which the emissions are likely to be steady or fluctuating and the impact of this on the model chosen;
- likely uncertainties associated with the meteorological data;
- plausible worst case scenarios;

These uncertainties should be acknowledged in consideration of the isopleths.

Once built, the model should be run for different design/what if options in order to show that BAT/appropriate measures are being proposed and to test the uncertainties.

To represent conditions for an "average year" hourly meteorological data for a period of at least three, preferably five years should be used. Data can be sourced from the following sources.

- A representative meteorological station;
- If such a station is not available or the site has specific local features that are likely to influence dispersion significantly, consideration should be given to the use of site specific predictive meteorological datasets derived from analysis of synoptic data. Data of sufficient quality for use in steady state and non steady state models is available commercially from a number of sources (e.g. TAPM data from the Air Pollution Model; MM5 data derived from the fifth generation Mesoscale Model)
- Your own weather station if you have one on the site. You should demonstrate that the siting of this will give a true representation of the conditions of the site.

Appendix 4 – What we are looking for in an odour management plan

Situations where Odour Management Plans (OMPs) would be required are discussed in Section 2 of this guidance.

This appendix discusses the purpose of OMPs and outlines the elements we consider to be essential. Odour management at some sites which have a high potential for odour pollution can be a major challenge. Accordingly, OMPs for these sites will need to be detailed and robust. Conversely, sites with a low odour potential will require comparatively simple and concise OMPs.

Objectives

OMPs should be designed to:

- employ appropriate methods, including monitoring and contingencies, to control and minimise odour pollution;
- prevent unacceptable odour pollution at all times;
- reduce the risk of odour releasing incidents or accidents by anticipating them and planning accordingly.

All OMPs will need to consider sources, releases and impacts, and use these to identify cost-effective opportunities for odour management. For a particular activity, some methods may be more effective/applicable than others. Sample OMPs, templates or plans produced for other sites are often helpful starting points.

Primary odour control measures

Source materials

The OMP must include an inventory, with descriptions and quantities, of all potentially odorous solid, liquid and gaseous materials held on site across the full range of operating conditions. These should not be confused with emissions to atmosphere, which are considered under the Releases heading. Understanding the nature and extent of the stock of odorous materials held on site is key to recognising and exploiting control opportunities. Management of these materials may involve total quantity limits or holding conditions designed to reduce the material's odour potential. Holding times or conditions for feedstock materials before they arrive at the site are frequently very important for waste management activities.

Releases

Management of releases includes reducing evaporation and, if needed, containment and abatement. Where odorous gasses are finally released, controlling the height of release through a stack or the timing of releases through management of activities can influence dispersion before there is an impact on people.

Impacts

Minimising the impacts of odour pollution requires an understanding of the surrounding community. What activities are people engaged in and how does this influence their sensitivity? What is the pattern of these activities over time? How do odours from the site

affect exposed community members and what concerns do they raise? How is the tolerance of the community towards odour pollution affected by broader perceptions of the company, the site, the activity or individual employees?

General

The best OMPs will include a number of simple measures which each make a significant contribution to the overall objectives. OMPs which rely on single measures, such as containment and abatement systems, can be vulnerable to minor failures and may not provide the most cost effective solution.

Where appropriate, control measures should be backed up by professional engineering assessments. This is particularly important for complex processes or containment and abatement systems. Where pollution management depends upon enhanced dispersion, the choice of measures should normally be backed up with modelling to show the difference made by the enhancement.

Monitoring

All monitoring should clearly relate to the assessment of odour control and complete records must be kept in an auditable format. Appropriate monitoring must be undertaken for every stage of process control (i.e. emissions, dispersion and impacts). The interpretation of monitoring results should be considered in advance and, where appropriate, trigger values should be specified for contingency measures.

Process

The only way to determine whether the processes on site are under control, and to keep them under control, is to do appropriate monitoring. This may involve sophisticated analysis used by highly qualified individuals. However, visual assessments or simple measurements of weights and volumes may be equally important.

For example, monitoring of a composting site should seek to ensure that parameters such as moisture, texture, oxygen levels and temperature are all within suitable ranges and used to inform process management decisions. Process monitoring will often need to include parameters relating to feedstock materials before they even arrive at the site. Factors such as holding times and conditions can have a profound impact on the odour potential of feedstock materials. The quantity of material held on site, compared to the capacity limit, is often a key indicator of whether a composting process is under control and likely to cause odour problems.

Process monitoring should reflect a thorough understanding of the process in question and factors which could influence odorous releases.

Emissions

As with sources, releases monitoring must provide good evidence that emissions are well managed and that any control measures are working as intended. Particularly in cases where emissions are released through one or more vents or stacks, it is often appropriate to specify performance criteria for any abatement equipment. This may be in the form of odour units through dilution olfactometry (taking volumes into account) or, where available, suitable surrogate measurements which can be more easily monitored. The Environment Agency will

normally seek to incorporate these performance criteria into the environmental permit in the form of Emissions Limit Values (ELVs).

Dispersion

Meteorological monitoring can identify when dispersion conditions are poor, or help to interpret exposure or impact monitoring data. Particular attention should be paid to the location of instruments. Knowing when dispersion conditions are poor can also inform decisions to implement additional short-term odour control contingency measures. The OMP should demonstrate that poor dispersion conditions can be identified and dealt with.

Exposure / impact

While complaints are never a substitute for comprehensive process and emissions monitoring, they are a valuable indicator of offsite odour impact. Procedures should be in place to receive comments from the community and act upon them. The receipt of a complaint may be an appropriate trigger for an internal investigation into the efficacy of current control measures.

Undertaking additional odour observations in the community may be useful, but this must be well planned and its limitations need to be recognised. People who work on odorous sites may be uniquely unqualified to undertake this assessment, either because of adaptation or personal assessments of offensiveness. Also, odours can be highly local and transient. They may have passed by the time an investigator arrives so the mere failure to confirm the observation would not alone justify a decision to take no further action.

For sites with ongoing odour problems, it may be beneficial to recruit individuals in the community to undertake periodic offsite odour surveys or to keep odour diaries. This can be done either on a voluntary or paid basis.

It is not possible to use instruments to measure odour in ambient air directly. However, very occasionally it may be possible to undertake surrogate measurements which are indicative of odours. This may be through direct measurement of chemicals which are themselves odorous, such as hydrogen sulphide. In other cases, odourless chemicals such as methane may be associated with odorous emissions of landfill gas.

Contingency control measures

Where trigger values have been exceeded or observations indicate odour pollution an operator will be required to take appropriate contingency measures. These measures may be aimed at:

- investigating the pollution incident and its cause(s);
- bringing the process back under control;
- temporary or permanent establishment or reinstatement of emissions controls; and/or
- minimising exposure or annoyance effects.

There are several key factors in preparing for effective contingency management

- anticipate what might go wrong;
- consider how problems might be revealed in monitoring;
- decide how incidents should be managed; and

- make appropriate preparations in advance.

In many cases it is reasonable to expect that the site will experience times when there are poor dispersion conditions and/or where the community is likely to be more sensitive. Under these conditions, contingency measures may be used to enhance the performance of existing controls and additional short-term measures can be used to further control odour pollution.

Contingencies will need to build upon an understanding of your process, emissions and dispersion, as already discussed. Where appropriate, we will also expect to see an escalation of contingency measures where more moderate methods are not successful. This may involve the use of a backstop contingency measure which results in the temporarily cessation of relevant activities, such as waste acceptance, until the process and emissions can be brought back under control.

There should also be a method of determining when contingency measures are no longer needed.

Repeated or long-term problems will need to be dealt with through more permanent changes to process controls or abatement measures.

Incidents and emergencies

Operators must consider what incidents or emergencies might adversely affect the control of odour pollution. With this knowledge, they must then plan and take appropriate steps to reduce the likelihood of the incident occurring, minimise any impacts if the incident were to occur, and recover control of the process as quickly as possible. This analysis and approach must all be documented in the OMP.

It is not necessary to consider events which are either very unlikely to occur or where odour would be a minor element of the overall environmental impact. For example, if there were to be a major flooding event which affected the site and prevented staff from getting to work, then odours would be a relatively minor aspect of the overall disruption and environmental impact.

However, events that are uncommon but reasonably foreseeable which could affect the running of the site and cause odour problems should be addressed e.g. deliveries may be affected from time to time or staff (internal and external) may be unavailable for some reason e.g. illness. The OMP should contain measures to deal with such eventualities. Other examples of reasonably foreseeable events are on-site breakdowns or loss of process control.

Organisation

Once we have reviewed and approved an OMP an operator will be required to implement it faithfully. We recommend that operators structure an OMP carefully to ensure that all the issues highlighted in this guidance are addressed and that the resulting document can be used effectively and with ease by relevant employees. It effectively forms part of your environmental management system.

Table A4.1 – Summary of odorous emissions pathways and impacts

Sources	**1 Inventories of odorous chemicals:** The way processes are managed can encourage the breakdown of odorous chemicals or generate more. The formation of odours will begin before materials are received so inventory control must begin before arrival at the site. **2 Transfer to air:** Only volatile (gaseous) chemicals can be detected. If they can be trapped in a liquid or solid state they will not cause odour exposure. **3 Release to atmosphere:** Containment of odorous air, followed by treatment (e.g. scrubbing) of emissions is often necessary but can be very expensive.
Pathways	**4 Dispersion:** Movement and dilution in ambient air is a natural phenomenon which may be influenced by releasing through an elevated stack or increasing the distance from receptors. **5 Exposure of individuals:** Asking people to leave the area or to stay indoors with windows closed are not appropriate long-term solutions to odour impacts. However, awareness of factors which influence the pattern of exposure can facilitate an understanding of the likely annoyance effects.
Receptors	**6 Perception:** Masking agents and perfumes often cause more problems than they solve, so intervention at this stage is generally inappropriate. Nevertheless, understanding perception is one of the key factors in the effective management of odour. **7 The meaning:** Natural gas and LPG are deliberately odorised and users are encouraged to take action if they smell it because the odour means danger. Most odours do not represent a hazard in the same way and providing information about the source can sometimes help to reduce anxiety. **8 Personal coping strategies:** Some individuals will cope with the stress of odours by trying to deal with the problem (e.g. by making complaints), and may be sensitive to lower levels of exposure. Others will seek to modify their own emotional response, and be less sensitive to annoyance. Personal reactions one way or another are influenced by factors such as economic interest, perception of threat or whether people are working or resting.
Impacts	**9 Secondary consequences:** Chronic odour exposure can result in profound economic and social consequences for an area (e.g. people who can afford to move away). It may also give rise to health issues e.g. allergic or psychosomatic responses.

Bibliography

Official publications:

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

Enforcement and Sanctions Statement and Guidance, Environment Agency link page
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H1 Part 1 – Environmental Risk Assessment
http://www.environment-agency.gov.uk/business/topics/permitting/36414.aspx

Review of Dispersion Modelling for Odour Predictions – Environment Agency 2007
http://publications.environment-agency.gov.uk/epages/eapublications.storefront?lang=_e

Best Avalable Techniques (BAT) / BAT reference documents (BREFs)
http://eippcb.jrc.es/reference/

Data Protection Act, 1998 on the Information Commissioner's Office (ICO) Website
http://www.ico.gov.uk/for_organisations/data_protection.aspx

Odour Guidance for Local Authorities, Defra, March 2010
http://www.defra.gov.uk/environment/quality/local/nuisance/odour/documents/local-auth-guidance.pdf

Air quality guidelines for Europe, 1987 (WHO Regional Publications, European Series No. 23) Please note that the online version is abridged.

Methods

BS EN 13725 2003: Air Quality, Determination of odour concentration by dynamic olfactometry

VDI 3882 Part 1 – Olfactometry; determination of odour intensity, and Part 2 – determination of Hedonic Odour Tone (English translation available)

VDI 3883 Part 2 – Determination of Annoyance Parameters by Questioning, Repeated Brief Questioning of Neighbour Panellists (English translation available)

Nasal Ranger – Operations Manual http://www.nasalranger.com/Operations.cfm

Measurement of Fugitive Emissions at a Landfill Practicing Leachate Recirculation and Air Injection, USEPA, EPA-600/R-05/088 August 2005
http://www.epa.gov/nrmrl/pubs/600r05088/600r05088.htm (Emissions assessment tools based upon long path ambient monitoring of methane.)

Odours in Wastewater Treatment, Measurement, Modelling and Control, R. Stuetz, F.B. Frechen, 2007, ISBN-10: 1900222469 (includes methods which may be more widely applied)

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Practical Handbook of Compost Engineering 2nd ed, R T Haug 1993 ISBN 0-87371-373-7 (Introduces process control methods which will help manage the production and breakdown of odorous chemicals in composting activities)

Odour and Volatile Organic Compounds: Measurement, Regulation and Control Techniques: Selected Proceedings of the 1st IWA International Conference on Odour and Volatile Organic Compounds: Measurement, Regulation and Control Techniques, held in Sydney, Australia, 25-29 March 2001, Editor(s): John Kaiyun Jiang, 2001, ISBN: 9781843394051

Biofiltration for Air Pollution Control, Joseph Deviny et. al., 1998, ISBN-10: 1566702895 (a thorough textbook on biofiltration which is equally relevant to odour)

Suggested Reading

Hedonics of Odours and Odour Descriptors: Journal of the Air Pollution Control Association, July 1984, Vol 34 No 7 Dravnicks A, Masurat, Lamm, R A

Odor and VOC Handbook (McGraw-Hill Handbooks) 1998 ISBN-10: 0070525234

Jacobson's Organ, Lyall Watson, W. W. Norton & Co., 2007, ISBN-10: 0393332918 (good general description of odour perception – the jacobson's organ per say is not relevant)

Learning to Smell: Olfactory Perception from Neurobiology to Behavior, Donald A. Wilson, Richard J. Stevenson, 2006, ISBN-10: 0801883687

Odour Sensation & Memory, Trygg Engen, 1991, ISBN-10: 0275941116

Tastes and Aromas, Annesley J. Watson (Author), Graham A. Bell (Editor) ISBN-10: 0632055448 (Useful background information but focussed on the food industry)

Sampling for Measurement of Odours, P Gostelow et al, ISBN 9781843390336

The Scent of Desire, Rachel Herz, ISBN-10: 0060825383 (Easy to read and the first couple of chapters give a good general description of our hedonic assessment and emotional response to odours)

Useful Web Sites

Professor Tim Jacobs at Cardiff University: http://www.cf.ac.uk/biosi/staffinfo/jacob/ There is a link near the top of this page entitled 'Go To Smell'. This will take you to a series of short articles on odour.

Leffingwell Associates: http://www.leffingwell.com/ Primarily concerns flavours and perfumes, but most of the principles are the same. Contains a useful introductory article on olfaction. http://www.leffingwell.com/olfaction.htm

St Croix Sensory: A collection of articles, mostly produced by St Croix http://www.fivesenses.com/Research_Publications.cfm

Nobel Institute press release for the 2004 award to Richard Axel and Linda Buck for Physiology and Medicine http://nobelprize.org/nobel_prizes/medicine/laureates/2004/press.html

Glossary

Adaptation: The normal desensitisation of individuals to particular odours. See Adaptation in Appendix 2

Benchmark Levels: see Benchmark Levels in Appendix 3

Bespoke Permits: A regulated site may not qualify for a Standard Permit, either because it poses a higher environmental risk, because it cannot work within the limitations imposed by Standard Permits, or because a Standard Permit is not available for the activity or activities carried out. If so, we will issue a Bespoke Permit. This is tailored to the individual circumstances and environmental hazards posed by the site. See also: Standard Permits.

Cold Drainage Flows: see Cold Drainage Flow in Appendix 2

Dynamic Dilution Olfactometry (DDO): This is based on "dilution to threshold" of a gas sample containing multiple components. See also BS EN 13725 for a detailed description of the method. Se section 5.6.

Detection threshold: The concentration at which an odorous chemical or mixture can be just detected. This is usually assessed as an average for populations, because individual people will have very different sensitivities.

Enforcement Action: Enforcement means any action we take where we suspect an offence has occurred or in some cases is about to occur. This may range from providing advice and guidance, serving notices through to prosecution, or any combination that best achieves the desired outcome. See the enforcement pages of our web site.

Hedonic tone: The generally accepted degree of pleasantness or unpleasantness (offensiveness) for a particular odour. ISO 5492. See Appendices 2 and 3.

Intensity: An assessment of odour strength based on an initial perception. This perception strength will rapidly diminish with constant exposure. The relationship between odour intensity and odour concentration depends on the specific intensity of the chemical or mixture being detected. Assessments can be made using the German method VDI 3882. See Section 2.

Isopleth: A line on a map connecting places registering the same amount or ratio of some geographical or meteorological phenomenon or phenomena. Commonly used to illustrate the output of odour models.

Long path-length monitoring (e.g. Boreal Laser) can measure Volatile Organic Compounds (VOCs) or a limited range of individual chemicals. See Chemical Monitoring. See bibliography entry for 'Measurement of Fugitive Emissions at a Landfill.

Odorous materials / substances / wastes: Materials that contain and have the potential to emit volatile odorous chemicals.

Offensiveness: See Section 3

Olfactory fatigue: Often confused with adaptation, this phenomenon is believed to be exclusively associated with exposure to H2S. At a concentration of about 100ppm, the H2S

causes rapid paralysis of nerves in the nose. This results in complete but temporary loss of smell.

OMP: Odour Management Plan.

Pollution: See definition and reference in Section 3.

Recognition Threshold: The concentration at which an odour can be identified. This is typically several times the detection threshold.

Source Term: This is the quantity of emissions being released from a source. Units for the purposes of odour will typically be (odour units * cubic metres / sec).

Standard Permit: A type of permit issued under the Environmental Permitting Regulations containing standard rules for defined activities. The permit cannot be tailored to site specific requirements.

Tedlar Bags: These are manufactured from Polyvinyl fluoride PVF (Tedlar) film. They are generally inert and can be used to collect samples containing common solvents, hydrocarbons, chlorinated solvents, and many other classes of compounds. They are commonly used to collect low-level sulphur gases, but only if the bag fittings are non-metallic (polypropylene, Teflon, or Nylon). Sample hold time will vary for different classes of compounds

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