



How to comply with your environmental permit

Additional guidance for:

H4 Odour Management

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1. Introduction

This document is part of a suite of guidance notes issued by Natural Resources Wales¹. 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 Natural Resources Wales'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. A complete list of the sector and “horizontal” notes, 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 UWWTD² 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.

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

¹ In consultation with NIEA. For the legislative framework in Northern Ireland contact NIEA

² UWWTD – Urban Waste Water Treatment Directive

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 Natural Resources Wales, unless the operator has used appropriate measures, including, but not limited to, those specified in an approved odour management plan, to prevent or where that is not practicable to minimise the odour.*³

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.

³ 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.

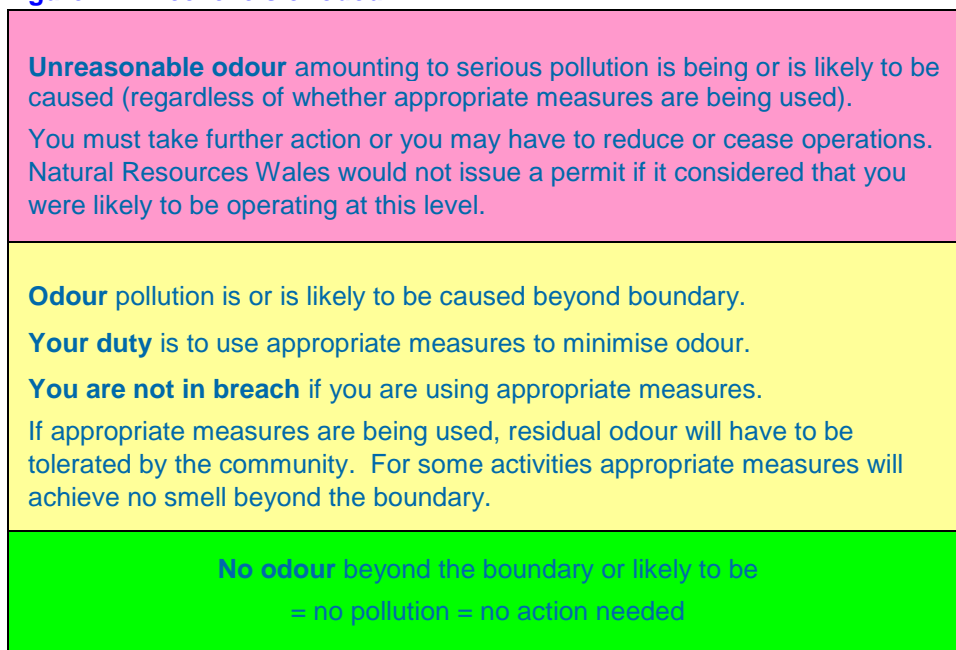
The underlined portion of the odour boundary condition ensures that operators will not be in breach of that condition provided they are using appropriate measures. However, even if the operator is using all appropriate measures, if we consider the residual odour is at such a level that it is unreasonable 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 futureproof your investment.

Figure 1 illustrates this approach.

Figure 1- Three levels of odour



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

Your permit conditions

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 Natural Resources Wales.***
- (b) If notified by Natural Resources Wales that the activities are giving rise to pollution, the operator shall submit to Natural Resources Wales 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 Natural Resources Wales that the activities are giving rise to pollution outside the site due to odour, submit to Natural Resources Wales 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 Natural Resources Wales.***

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.

Assessing the level of odour pollution and appropriate measures

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.

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.

Assessing the level of odour pollution and appropriate measures

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.

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.

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.

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.⁴

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.

⁴ The definition of pollution is set out in Regulation 2 of the EP Regulations.

Assessing the level of odour pollution and appropriate measures

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**⁵ acronym is a useful reminder of the factors that will determine the degree of odour pollution

- **F**requency of detection;
- **I**ntensity as perceived⁶;
- **D**uration of exposure;
- **O**ffensiveness⁷;
- **R**eceptor 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;

⁵ The term FIDOL is sometimes used instead, in which the L stands for Location (of receptors).

⁶ **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.

⁷ **The offensiveness** of an odour includes its hedonic tone. Offensiveness takes account of exposure and the attributes that determine nuisance sensitivity whereas hedonic tone 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](#).

Control measures

- 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 passersby.
- 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.

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.

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);
- the relevant sections of this guidance;
- more specific guidance including Natural Resources Wales sector guidance notes (
- 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:

Control measures

- 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 valve 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.

Control measures

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 Natural Resources Wales 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 Natural Resources Wales 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.

Enforcement and Sanctions Statement and Guidance, Natural Resources Wales website

Environmental Permitting Regulations Sector Guidance Notes, Natural Resources Wales website

H1 Part 1 – Environmental Risk Assessment

Review of Dispersion Modelling for Odour Predictions – Natural Resources Wales website

Odour Guidance for Local Authorities, Defra, website

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

Measurement of Fugitive Emissions at a Landfill Practicing Leachate Recirculation and Air Injection, USEPA, EPA-600/R-05/088 August 2005 (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)

Bibliography

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 se 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)

Glossary

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. See 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