Technical Guidance Note

IPPC SRG 6.02 (Farming)

Integrated Pollution Prevention and Control

Odour Management at Intensive Livestock installations

ENVIRONMENT AGENCY

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Version 1, Draft 1	November 2000	Included as appendix in version 2 of Standard Farming Installation Rules
Version 1	May 2003	Guidance to be provided only to those required to produce odour management plan.

Contents

1 Background

1.1 What is IPPC?

Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. In England and Wales IPPC operates under the Pollution Prevention and Control (England & Wales) Regulations 2000 (Reference 1). These Regulations were made under the Pollution Prevention and Control (PPC) Act 1999, and implement the EC Directive 96/61 on IPPC. The Regulatory Regime applies to many industrial sectors, including the intensive farming of pigs and poultry. The threshold for such farms to be regulated under IPPC is:

- 40,000 places for poultry; or
- 2,000 places for production pigs (over 30kg); or
- 750 places for sows.

Regulation is achieved through the issue of a permit from the Environment Agency which covers all aspects of the operation of the farm as defined by installation or other boundaries. To gain a permit, Operators have to show that they have systematically developed proposals to apply the 'Best Available Techniques' (BAT) and meet other requirements for environmental protection, taking account of relevant local factors.

In Scotland SEPA is responsible for the regulatory control of IPPC installations and issue of Permits. In Northern Ireland, the Environment and Heritage Service is responsible.

The Agency, SEPA and NIEHS has developed a simplified permitting approach for the farming sector, through the development of Standard Farming Installation Rules (Reference 3). These rules define BAT for the farming sector. These rules are being piloted, with a longer term view to developing General Binding Rules which would be made by the Secretary of State. Aspects of odour management are integrated throughout the Standard Farming Installation Rules, but in some cases site specific measures will be needed, and these must be identified in an Odour Management Plan.

1.2 Who should use this guidance?

This guidance is intended to be specifically targeted at the pig and poultry sector, and includes many of the principles applied to all sectors regulated under IPPC referred to in Horizontal Guidance (References 5 & 6). The Agency will refer to this Horizontal Guidance in determining conditions for odour at pig and poultry installations.

You should use this guidance if:

- You answered 'yes' to question 2.3.6 on the application form, ie sensitive receptors are located within 400m of the unit; and/or
- The unit has a history of odour-related complaints; and/or
- You are in the process of planning for a new unit, or extending an existing one – this guidance will provide information on best practice and impact assessment requirements.

1.3 How you should use this guidance

You should not use this guidance in isolation from the Standard Farming Installation Rules.

Section 2 provides guidance on the sources of odour, and some of the measures to minimise emissions.

Section 3 provides guidance on writing an odour management plan. This section should be used if you have sensitive receptors within 400m of the unit and/or the unit has a history of odour related complaints. You will need to consider some of the measures in section 2 in your odour management plan.

Section 4 provides guidance on carrying out an odour impact assessment. This section should be used if you are in the process of planning for a new unit, or extending a new one. An odour impact

assessment will be required as part of the process of applying for planning permission. You may need to consult a odour specialist to complete the assessment, and should ask them to cover the points in this guidance.

1.4 What standards of odour control are expected?

1.4.1 What standard of control are we aiming for?

In the case of odour, pollution is considered in terms of causing offence to the sense of smell, ie causing annoyance to people who live in the area or are there for some other reason, through exposure to odour.

The point at which 'pollution' in the form of offence to the sense of smell is occurring, is taken to be the point at which there is 'reasonable cause for annoyance' (Reference 5).

The aim of the legislation is to achieve 'no reasonable cause for annoyance' by persons beyond the boundary of the unit, ie sensitive receptors, as far as is possible using Best Available Techniques.

1.4.2 Who are sensitive receptors?

The person in control of the unit would not normally be considered to be a sensitive receptor. Persons who live in close proximity in tied housing may be sensitive receptors (consider the families of the farm workers). If such properties are rented to people who do not work on the farm, the tenants are likely to be sensitive receptors, even if they rent with the knowledge that there is an odour source nearby, or recognise that odour is a feature of the rural environment. In any particular situation however, the interpretation of the courts will be the decisive factor.

1.4.3 What is 'no reasonable cause for annoyance'?

The amount of annoyance should not be assessed only by means of the number of complaints. You should still use best practice to keep odour levels as low as reasonably possible where people live close by, even if complaints are rarely received.

The legislation requires that the amount that you spend on taking measures to reduce odour should be in proportion to the annoyance caused or potential to cause annoyance. Good practice should be adhered to at all times by all farm units, but if a large number of complaints are received, or the unit is close to a built up area then you may have to expend more effort to reduce odour. Best Available Techniques cover management techniques (i.e. Best Practice), as well as hardware, to control odour.

1.4.4 Standards for new units

New units will have to use Best Available Techniques from the outset. As part of the planning process it is likely that an applicant will be required to undertake odour modelling to predict the odour emission.

The indicative exposure level criterion which equates to 'no pollution', ie no reasonable cause for annoyance is: **$3ou_E$ as a 98^{th} percentile of hourly means** at sensitive receptors, with such an adjustment as is appropriate to take account of local circumstances. This is the point at which the smell is recognisable eg. as pig odour (section 4.1.3). Above this level 'pollution' is said to be occurring, and it is likely complaints will be made. The actual exposure limit applied in any particular situation will take account of the sensitivity of the local environment. The Agency will consider the outputs from an odour impact assessment against these criterion.

1.4.5 Standards for existing units

Existing units may be allowed a longer timescale to upgrade where meeting BAT will involve capital expenditure, and $3OU_E$ may not be the appropriate standard on these farms in all circumstances. Existing farm units will be expected however to adopt good management practices from the date of being granted a Permit. Any required changes in operation will be detailed in an improvement plan agreed with the Agency.

2 Management of Odour

2.1 General aspects of odour management

2.1.1 Overview

This guidance gives an overview of the principles of best practice for odour reduction and containment, as they relate to each of the Standard Farming Installation Rules. Not all aspects will apply to all units and some units will have arrangements which are not described here. You will need to pick out those elements which most closely match your circumstances and add in any other sources or problems.

The nature of intensive livestock operations mean that preventing odour generation at source is rarely possible as animals are inherently odorous. However, there are many things than can be done, often at low cost, to minimise odour or to prevent it reaching neighbours.

In most cases, attention to housekeeping and good operational practices should be capable of achieving a significant reduction in the level of exposure experienced at sensitive receptors.

In cases where all reasonable measures have been taken and have not succeeded in reducing emissions to the point where the exposure of sensitive receptors (local residents) is acceptable then 'end of pipe' abatement may need to be considered. This may require odour to be contained at source and extracted to the abatement system with minimum fugitive losses. Biofilters or absorption 'scrubber' systems (chemical or biological) are the favoured choice because of their effectiveness and ease of operation. This is obviously a more expensive option so all effort should be made to improve the housekeeping aspects of the operation. Guidance on such systems is beyond the scope of this document.

2.1.2 Using location / siting as a means of odour control

Care should be taken to site particularly odorous activities away from neighbours. Distance helps to dilute odours and making sure that odour sources are not upwind of houses (i.e. the prevailing wind direction) helps in reducing the impact of odours.

Although the siting of the unit will have been considered as part of the planning application, there may be some choice as regards, for example, the siting of slurry and manure storage areas, deciding what will be spread on fields near houses etc. The day to day operation of the unit is under the control of the site Operator who can play a major part in reducing odour levels.

2.1.3 Trees and hedges as an odour barrier

Vegetation barriers (trees and hedges) are sometimes said to provide a degree of odour control if planted between the source and local dwellings. However there is no evidence that landscaping has any effect in dispersing the odour. The psychological effect of removing the odour source from view probably has a much greater overall effect on the perception of odour rather than the actual odour reduction offered.

2.1.4 Complaint procedure

A procedure should be established for verifying and responding to complaints about odour. Records should be kept.

2.1.5 The use of odour masking/neutralising agents (air spraying)

The use of additives to mask, counteract or neutralise odour are only generally suitable for short term operations, such as transfer of material or for addition to a particularly odorous batch of slurry, for example. They should not be regarded as a long term approach and, indeed, would not generally be cost effective in the long term.

The smell of masking agents can often attract as many complaints as the smell they are trying to cover.

The use of manure or slurry additives is discussed in Section 2.6.3.

2.2 Sources of Odour

2.2.1 Livestock housing

The odour associated with livestock houses tends to be dominated by ammonia. Hydrogen sulphide can also be present. This document does not deal specifically with **ammonia** control but with odour control in more general terms. Many of the actions taken to minimise odour will also minimise ammonia. Specific information and requirements relating to ammonia emissions can be found in the Standard Farming Installation Rules.

2.2.2 Manure and slurry

Odour arises primarily from the presence of manure/slurry and the biological changes which take place as it decomposes and also the body odour of the livestock. Some odour also arises as a result of cleaning and disinfection of sheds - from the removal of accumulated manure and also from fumigants used. Storage of manure or slurry in the open is also a source of odour.

2.2.3 Dust

An important mechanism in the release to atmosphere of odour is the presence and subsequent emission via the ventilation system of suspended **dust particles** originating from bedding, feed and the animals themselves. Odorous compounds may be adsorbed onto these particles and the particles themselves may decompose releasing volatile compounds. There are specific rules relating to dust minimisation in the Standard Farming Installation Rules.

2.2.4 Factors affecting the release of odour

The level of odour emissions from intensive livestock units is dependent on a number of factors, principally:

- size of operation;
- the type of building/ventilation
- type of operation and the rearing cycle
- the feeding regime
- the way in which the operation is managed
- storage arrangements for manure and slurry
- land spreading practices

The impact of those emissions on the local environment depends upon:

- proximity to local housing and other sensitive receptors.
- the nature of the local topography and prevalent weather conditions

2.3 Aspects of odour management common to all operations

2.3.1 Selection and use of animal feed

The Standard Farming Installation Rules (Section 2.2.2) give guidance on the selection and use of pig feeds and poultry feeds at different stages in the rearing cycle in order to reduce nitrogen excretion. A high protein diet increases the nitrogen and sulphur content of manure, contributing to emissions of ammonia to air and other odorous compounds when the manure undergoes anaerobic degradation.

A number of different feed additives are available which claim to reduce odour from manure. In most cases these have not been proven sufficiently well for any to be recommended.

2.3.2 Feed delivery, milling and preparation

Good housekeeping measures (Standard Farming Installation Rules section 2.3.1) include:

- avoiding accumulation of waste feed, cleaning up spills
- avoiding overflow and spillage from feed and drinking systems.

The addition of odorous by-products such as whey and fish meal to feed will increase the odour level of the feed (and accumulated spillages will smell more). Storage of these products may also lead to odour and dust generation.

Finely ground feeds and long feed drops onto floors should be avoided because they increase dust emissions. Odours can be absorbed onto particulate matter and then carried out of the building via the ventilation system.

Odours arising from storage of feed can be minimised by covering the storage containers or through the use of purpose built silos. Such storage areas should be protected from collision damage.

The delivery of the feed to the storage areas, and from the storage container to the feeding station should be through a closed system to minimise the generation of dust.

Mixing and milling of dry foodstuffs should be carried out using closed systems or in an environment from which emissions can be minimised.

2.3.3 Disposal of carcasses

Carcasses should be removed frequently to prevent odour-related annoyance and be covered to prevent access by birds or rodents using plastic bags or lidded bins where possible (Standard Farming Installation Rules section 2.2.5).

2.3.4 Ventilation and humidity

Ventilation rates are determined by the needs of the animals and vary with season. Odour will be carried out of the houses with exhausted air and the exhaust rate will tend to be highest when the outside temperature is high, generally in the summer months when the potential to cause odour annoyance is highest.

Ventilation systems should be run at the optimum rate for the number of animals present. Poor ventilation can result in excess humidity and excessive odour build up.

The design of ventilation systems is a specialist field but in general terms roof vents produce better dispersion of odorous releases than those positioned along the side of buildings. The operator should ensure that dust deposits around the ventilation discharge points are cleared away on a regular basis to prevent excessive buildup.

2.3.5 Atmospheric dispersion of odours

Once odorous emissions leave the source they undergo dilution and dispersion in the atmosphere downwind of the unit. Where odours are released at height, they are likely to be more effectively dispersed than those released at a low level or, inadvertently, from open doors.

Roof (apex) vents produce better dispersion than side wall vents, but may lead to more fan noise being experienced at local houses. Increasing the height of vent discharge points above roof level may give better dispersion. Ducting the ventilation flow to a single chimney which emits at a much higher level will provide still further improvement although have the effect of making the odour detectable further away than was previously the case.

Chimney height calculation can be fairly complex and needs to consider a number of aspects relating to the emissions and the rate of emission, the temperature, the local topography and the location of receptors. It is best undertaken by a specialist.

2.3.6 Dirty water management to prevent stagnation

Stagnant water can be a source of odour. The following measures can help to ensure that dirty water is disposed of quickly and unintentional areas where water could accumulate and stagnate are minimised:

- Fit kerbs to concrete aprons to direct dirty water into drains
- Enclosing dirty water collection systems
- Emptying and cleaning dirty water collection systems to avoid allowing anaerobic conditions.
- Maintaining drains and concrete areas.
- Dealing quickly with dirty water generated when buildings are cleaned out at the end of the cycle.

2.4 Odour management in pig rearing

2.4.1 Odours from pig housing

The principal sources of odour during rearing are slurry or manure and bedding material. The way in which the slurry or manure are collected in the pig houses, ie underfloor and/or on the floor, the amount, the temperature and residence time will affect the amount of odour generated. Odour emissions from the housing can be minimised by keeping the pig pens clean, ie. by continually removing the slurry and regular removal of soiled straw or manure by flushing or scraping.

Other sources of odour are:

- The pigs themselves, both body odour and any manure on the skin
- Spilt feed
- Carcasses

2.4.2 Minimising odour arising from animals and their housing

In general terms:

- Odour emission rate increases with slatted floor area.
- Wintertime emissions are lower than summertime emissions.
- Pit ventilating increases odour emissions substantially.
- Frequent slurry removal by flushing with aerated slurry reduces the emission by about 30% in summer, but slightly increases the winter odour emission rate.

Techniques to abate emissions will depend on the type of housing and slurry or manure collection systems in place (Standard Farming Installation Rules section 2.3.3). For slurry based systems, techniques are aimed largely at reducing the surface area of the slurry, and to reduce the area of flooring which is damp. For manure based systems, which may be more, generous use of straw will bind nitrogen and prevent ammonia escaping, releasing odour.

Anaerobic breakdown (in the absence of oxygen), unless deliberately induced as a method of treating slurry is highly odorous and should be prevented by avoiding stagnation of wastes.

2.4.2.1 General hygiene

It is important to maintain a good standard of general cleanliness for animal welfare as well as for odour control. Any surface which is covered with manure will act as a source of odour. Therefore reducing the exposed surface will reduce the overall odour emission. Such surfaces include the animals themselves, as well as pens and flooring, in addition to areas around the buildings.

Dirty pens can be caused by a number of factors, for example:

- Poor management and building design.
- Poor ventilation design.
- Wrong pen shape.
- Poor floor surfaces.
- Incorrect construction of pen divisions.
- Badly sited feeding and watering facilities.

- Overstocking or understocking.

Some of these are design issues and should be addressed when planning new facilities or extending or replacing existing houses. However a lot can be done to minimise odour emissions by **keeping the pig pens clean**, by:

Slurry systems

- Removing slurry and manure to a suitable store as frequently as possible.
- Thorough cleaning and disinfection of pens once vacated.
- Cleaning slurry and drainage channels to clear deposits, which encourage microbial growth.
- Cleaning surfaces and ventilation shafts/cowls of dust deposits.
- Maintain drinkers and troughs to prevent leakage

Solid floor systems

- Providing drainage to avoid the accumulation of effluent in areas where it may collect and start to degrade in an anaerobic manner. The drained liquid should be collected in a closed tank.
- Repairing damaged concrete and drains to prevent ponding inside buildings
- Use of sufficient bedding material to absorb excreta and keep animals clean.
- Maintain drinkers and troughs to prevent leakage.
- Storage of bedding material in a dry area

2.4.2.2 Flooring

There is inconclusive evidence as regards the relative effectiveness of the floor types described in the Standard Farming Installation Rules in minimising odour (Section 2.2.3). Housekeeping will play a part in ensuring a good standard of hygiene, in addition to the floor design:

- Slats, pens and other surfaces should be cleaned regularly. High pressure hoses provide an effective means of removing accumulated deposits.
- Scraped areas should be maintained to prevent ponding or building up of urine.
- Slurry and manure should be flushed away or removed regularly as the underfloor storage of large amounts of slurry over a prolonged time is a major source of odour.
- Damaged flooring should be repaired as soon as possible.

2.5 Odour management in poultry rearing

2.5.1 Odours from poultry housing

Odours from poultry sheds come from a number of sources. They are mainly caused by the breakdown of faeces and urine. Other sources of odour are from waste food spilt onto floors, the scent glands of animals and animal feed. A major means of minimising odour emissions is through the use of good agricultural practice. Odour mitigation methods will be similar for all different poultry operations.

The Defra Code of Good Agricultural Practice for the Protection of Air (Reference 4) advises that the following factors contribute to the emission of odours from poultry sheds:

- the build up of slurry or manure on concrete around buildings;
- the removal and disposal of dead animals;
- the maintenance of drains;
- the cleanliness of bedding;
- the management of drinking systems, with particular emphasis on frequently adjusting nipple and drip cups to bird eye level to avoid spillage and wet litter;
- the stocking density;
- the moisture content of the litter ;
- the insulation of the buildings and the long term maintenance of that insulation;
- the ventilation and heating system;
- the type of heating;

- the composition of the feed, particularly its oil and fat content and its protein content;

The housekeeping practices at a well-run poultry operation should take these factors into account as part of their day to day management/operation of a site.

2.5.2 Minimising odour arising from animals and their housing

Odour from litter and manure based systems may be minimised by increasing the dry matter content of the litter or manure, by both preventing spillages of water and providing a drying mechanism. If the dry matter content is 60% or above, ammonia emissions are minimal. New buildings should be able to meet this criterion.

2.5.2.1 Dust

Dust emissions may be a problem particularly for larger birds. Odorous compounds may be adsorbed onto dust particles and the particles themselves may decompose releasing volatile compounds. It is therefore important to:

- Control the generation of dust within the house through management of litter moisture content and air quality.
- Minimise the amount of dust emitted from buildings
- Ensure **dust deposits around ventilation discharge points are cleared on a regular basis** to prevent excessive build up. Minimising dust production through good housekeeping and animal husbandry would be cost effective, in addition to the obvious welfare benefits.
- Discharges from cleaning operations should not be allowed to occur.

The odour emission from a building is dependent on particulate emission. Data published by Van Geelen (Reference 10) suggests that removing the dust fraction from an odorous stream reduces the odour concentration by about 65%.

2.5.2.2 Litter quality

Litter quality is affected by:

- temperature and ventilation,
- drinker type and management,
- feeder type and management,
- litter material and depth,
- condensation,
- stocking density,
- feed formulation and quality,
- and bird health.

Investigate the minimum ventilation and heating requirements. Ideally buildings should be heated by indirect firing systems. In new houses ventilation should be designed to remove moisture.

Investigate increasing the initial depth of litter. A depth maintained at 10-15 cm should be sufficient to absorb the moisture loading.

Litter removed from the buildings at the end of the production cycle should be stored dry. The storage area should be stored away from residential areas.

In egg production a belt manure removal system (ideally with forced air drying) should be used to avoid the accumulation of manure from caged layers. Where manure falls directly into a deep pit, ventilation of the pit should be provided to keep the manure dry.

The need to keep litter or manure dry does not apply to ducks but the need for good general hygiene and removal of excreta is relevant:

- Removal and disposal of dead animals;
- Maintenance of drains;
- Management of drinking systems;
- Stocking density;
- Provision of sufficient straw to bind nitrogen and prevent ammonia escaping.

2.5.2.3 Drinking systems

Fine tune daily management of drinking system to ensure that all litter is kept dry i.e. moisture content is less than 40%. Nipple drinkers and drip cups (operate on demand) should be used in preference to bell drinkers (always full of water) and they should be sited at the correct height to minimise spillage

For broilers and turkeys the requirement is for nipple drinkers to act as the main source of water, although time may be allowed for this to be applied to existing housing.

2.6 Odour and manure management

2.6.1 Slurry and manure handling

Slurry and manure handling and storage can be significant sources of odour (Standard Farming Installation Rules section 2.3.4). Effort to reduce odour from these sources can have a substantial positive effect on the overall odour impact of the unit on local receptors. In particular, anaerobic conditions can lead to the formation of high concentrations of odorous substances within slurry which will be released when it is disturbed:

- Roadways and other areas should be kept free of slurry or manure. Minimising the surface area of material exposed will reduce the odour emission.
- Waste feeds such as milk, whey, silage effluent or dirty water should not be added to the slurry if there is a risk of causing odour problems because of the location of the slurry store or treatment tanks, or from the spreading of waste. Wherever appropriate, silage effluent should be stored separately from slurry and manure.

2.6.2 Slurry and manure storage

Slurry and/or manure storage areas and any material separated from the slurry or any straw based manure should be stored as far away as possible from residential areas.

Covering or enclosing slurry storage tanks will stop or significantly reduce odour escaping to atmosphere.

The Standard Farming Installation Rules require that exposed surface areas of slurry in stores should be covered to minimise emissions of odour and ammonia - the options are to fit a rigid cover to a steel or concrete tank, or to use a floating cover of light expanded clay aggregate. Other covers, such as straw or peat will sink and do not reduce emissions effectively.

Fixed covers will reduce emissions, but the concentration of odour in the headspace can become very high. This may be released in one go when the cover is removed, producing very strong odours at receptors if not dispersed adequately in the air. This may cause particular annoyance, even if short lived. There may also be health & safety implications if workers are exposed to the air in the tank headspace.

Floating covers have the advantage of no headspace but will only work effectively if disturbance to the surface is minimised.

Some more permanent floating cover designs have an extraction system to remove gas.

New open storage tanks will not be allowed and plans must be in hand to replace or cover existing open tanks.

Reducing the surface area will help in reducing odour emissions. Any form of agitation or turbulence from pumping or stirring will increase the odour from the surface of an open tank. Bottom filling will minimise surface emissions. Formation of a crust may provide a degree of protection against odour emissions but turbulence from stirring can break the crust.

It is recognised that slurry mixing may be necessary to produce a suitable material for land application, but generally the preceding measure will reduce emissions of ammonia and odour. The frequency of stirring should be minimised.

Many of the requirements relating to storage of manure are aimed at avoiding the pollution of water courses by run-off. Odour minimisation is provided largely by keeping manure undercover in a storage building. Long-term field storage should be avoided as adequate cover is not possible.

2.6.3 Treatment of Slurries and manures

There are various options for slurry treatment, including screening, separation, composting, aeration and anaerobic digestion. **However, no rules are currently applicable.** A BAT determination will be needed for each case. In general:

- Separation of sludge by mechanical means, aeration or digestion can reduce the odour emitting potential.
- If an aerobic or anaerobic system is used to reduce the odour emission it should be large enough to handle all the slurry produced, and designed for this purpose. It should be operated according to the manufacturers instructions.
- When using aerobic treatment methods odour reductions and overall control is better when solid content is reduced.
- Monitoring should be undertaken to ensure that the appropriate conditions are maintained, particularly in the case of aerobic digestion.
- The solid content of the slurry store should be reduced using a separation stage. With less solid material present the need for stirring is reduced.

2.6.3.1 Slurry separation

The management of slurry can be improved by removing coarse solids. For example, for pig slurry comprising 2 to 4% dry matter, a simple wedge screen or vibrating screen can be used and the collected solids (8 to 12% dry matter) will self-drain if held in a suitable store. Separators that press, squeeze or screw the slurry against a fabric or perforated steel screen will produce a solid with a dry matter content ranging from 18 to 30%. If slurry is left in the collection pits for more than 3 to 5 days, degradation of material structure (becomes more fluid) can be expected making the separation process more difficult.

The solid portion, 10 to 20% of the original slurry volume, can be stacked and stored in a similar way to farmyard manure. At higher dry matter levels the material will be suitable for composting. The separated liquid portion, which is 80 to 90% of the original, can therefore be pumped to store. Once separated, storing the liquid portion is easier because there is less risk of crust formation and solid settling and therefore mixing in store only needs to be carried out occasionally which results in a reduction of odours released during storage.

If solids are not removed from the slurry, the organic loading within the slurry store (lagoon or tank) will become increasingly anaerobic. The presence of solid material provides an additional demand on available oxygen, thus increasing the amount of ammonia and hydrogen sulphide produced when the slurry is agitated.

2.6.3.2 Composting

Composting can significantly reduce the odour from manure. However the composting process itself can be very odorous.

The presence of oxygen is essential to the composting process and to prevent odorous anaerobic breakdown. Manure should be stored in narrow windrows no longer than 10-15m long and no taller than 3m high to assist composting. A method of collecting any run-off from the store should be provided.

Composting of manures will be controlled through the Animal By-products Regulations 2002, on which DEFRA is currently developing guidance. The Agency will not be the Regulator for these Regulations which will be enforced by Local Authorities.

2.6.3.3 Slurry and manure additives

There are a number of additives available which aim to change the qualities of the manure for a number of reasons, for example to improve its handling qualities, its fertilising value, its stability or to reduce the emission of volatile compounds and odour by changing its chemical composition.

In most cases these have not been proven sufficiently well for any to be recommended, although there are a number of anecdotal success stories.

Other treatment methods can be used to control odour emissions during storage. Additives are commercially available that claim to control odour emissions; the main types are:

- Oxidising agents.
- Deodorants which react with odorous compounds.
- Odour masking agents.
- Odour neutralising agents
- Biological agents – enzymes, bacteria
- Feed additives (reference 15)

These additives vary in effectiveness and are generally not a long-term solution. Their use has not been included within the Standard Farming Installation Rules.

2.7 Slurry and manure spreading

Odours released from animal manure or slurry spreading activities are one of the most frequent sources of odour complaint to Local Authorities. During spreading, odours can be detected from between 1000 to 3000 metres (in exceptional weather conditions (Reference 16) from the field. Several factors affect the amount of odour emitted during and after slurry or manure spreading, these include:

- Whether the material contains waste milk or silage effluent (increases the amount of odour released).
- Method of storage.
- Length of storage.
- Pre-treatment method employed (if any).
- Type of spreading equipment used.
- Rate of application to land.
- Weather.

The Standard Farming Installation Rules (Section 2.3.5) require that where spreading takes place on the Operators own land, it is done in accordance with an approved Manure Management Plan.

2.7.1.1 Method of spreading

The emission of odour is dependent on the method of spreading (reference 3):

- **Splash plate spreaders**

The production of small droplets maximises the release of the volatile compounds in slurry into the air. The odour concentration during spreading can therefore be many times higher than immediately afterwards. The larger the droplets and the lower of the trajectory, the lower the release of odour. It is preferable not to use splash plate spreaders near to housing.

- **Band spreaders** discharge slurry at ground level through a series of trailing pipes.

Measurement shows an odour reduction of 55-60% when compared to conventional splash plate spreaders.

- **Shallow channel application,** uses a mechanism to make grooves 50-70mm deep in the soil, 200-300mm apart and the slurry is directed into the channel immediately behind the cutting blade.

Measurement shows an odour reduction of 55-60% when compared to conventional splash plate spreaders.

- **Shallow injection,** slurry is applied at a depth of 50-80mm in grooves 250-300mm apart.

The grooves are closed again by press wheels or discs. The amount of odour emitted is approximately 85% less than for conventional spreaders.

- **Deep injection,** applies slurry at a depth of 120-300 mm in the soil using injector times, spaced about 500mm apart. The amount of odour emitted is about 85% less than for conventional spreaders.

Odour levels arising from different spreading techniques can vary with spreading method and burial technique. The data shows that although low trajectory spreaders reduce the initial odour impact at the time of spreading, the odour problem remains after spreading. Hence burial or injection of manure/slurry achieves a substantial reduction in odour emission.

2.7.1.2 General hygiene aspects

Avoid the overfilling of tankers or spreaders to avoid spillage. In particular take care not to spill slurry or manure onto roadways.

Machinery should be cleaned regularly

2.7.1.3 Timing and location

The following measures help reduce odorous emissions:

- Avoid spreading during periods of high humidity and very light winds or clear, still nights. During these meteorological conditions there is very little turbulence to disperse the odour. The best dispersion occurs on windy sunny days followed by cloudy windy nights.
- When odorous or partly composted manure has to be applied to land do not spread it close to houses. Where practicable, it should be spread onto arable land and then immediately ploughed in.
- Unless the slurry is band spread, injected or odourless, spreading should be avoided at evenings, weekends and bank holidays.

3 Writing an odour management plan

You will need to produce an odour management plan if:

- You answered 'yes' to question 2.3.6 on the application form, ie sensitive receptors are located within 400m of the unit, and/or
- The unit has a history of odour-related complaints.

3.1 How to write an odour management plan

To produce an odour management plan you should do the following

1. Identify the sources of odour and/or complaint on your farm

- What activities are going on when complaints are received?

  Walk round the site and think about where odours come from:
  - How much does odour increase during occasional operations such as animal loading, shed cleaning and removal of waste? Are complaints related to these activities?
  - Are there slurry pits or manure storage areas? Are these covered or uncovered? Where are they located in relation to local houses?
  - Is slurry or manure spread on the farm?
  - Are there deposits of slurry, manure or feed etc on roadways or in yards?
  - Are there uncovered skips or bins?

2. Look at the odour sources and corrective actions discussed in Section 2

Note down those sources or activities which **do** cause a problem on your unit and the types of corrective actions that you will need to highlight in your odour management plan.

3. Transfer the relevant information into the Odour Management Plan template in Section 4

- Identify each odour problem/source in Column 1.
- Select the appropriate corrective action from Section 2 for each problem.
- Adapt it to your particular circumstances – what would you do on your unit to achieve the same outcome?
- Identify the corrective actions in Column 2.

You should send your odour management plan together with your Permit application. Where you already have a Permit and need an odour management plan to deal with specific problems, you should discuss it with the Agency officer and then send a copy to the Agency.

You will be expected to follow the actions you have set out in the plan.

If there are complaints and you can show that you have complied with these actions then the Plan will need to be revised. You should start again at Point 1, above and discuss this with the Agency officer.

If you have not complied with the Plan and complaints are received, then you may be liable to enforcement action.
If you cannot control the odour by use of best practice then the Agency may require more stringent measures for odour control. It is therefore in your interest to ensure that the Odour Management Plan is adhered to by all those employed at the farm and visitors, contractors etc

3.2 Odour Management Plan Template and examples

This section contains a blank table (on the next page) on which to note down the farm-specific actions to be taken.

All of the columns in the table should be completed using the guidance given in Section 2 and in the Standard Farming Installation rules. You should adjust this as necessary to make it relevant to the odour problems on your particular unit.

Required actions should be broken down into individual tasks as far as possible. It is often helpful to identify the individuals who will carry out each task (if relevant) and when this will be done. The plan should also include actions to be taken if something goes wrong which will increase odour emissions (such as a spillage) and seasonal variation in emissions.

An example of the type of information used to complete the table is given below.

EXAMPLE

Odour problem	Actions you will take to reduce the odour	Completion Date
Carcasses start to smell prior to collection	• New arrangement made with [the company that collects the carcasses]. Collection now to be automatically made every two days unless we phone [person/number] to cancel a pick-up or to increase frequency. • Place in bins to keep vermin away. Ensure lid is tightly closed.	June 2003 July 2003
Complaints when slurry is spread next to New Road.	Change method of spreading to band-spreading on fields near roads & houses Review weather forecast before spreading – avoid periods of humid weather, light winds or clear still nights	March 2004 June 2003

Odour Management Plan

Ref: Farming rule (if applicable)	Odour problem	Actions you will take to reduce the odour	Completion Date

4 Odour impact assessment

This section describes different options for carrying out an odour impact assessment. Is also describes the information that should be contained in the impact assessment report. You may need to consult an odour expert in order to carry out an odour impact assessment.

You will need to carry out a full odour impact assessment if:

- You are applying for a Permit for a new unit and need to carry out an impact assessment for planning purposes.
- You are planning to extend an existing unit which needs Planning permission and an impact assessment.

It should be noted that an impact assessment which has been carried out for planning purposes may not contain sufficient information for an IPPC application. You should check with the Agency.

You may need to carry out an odour impact assessment if:

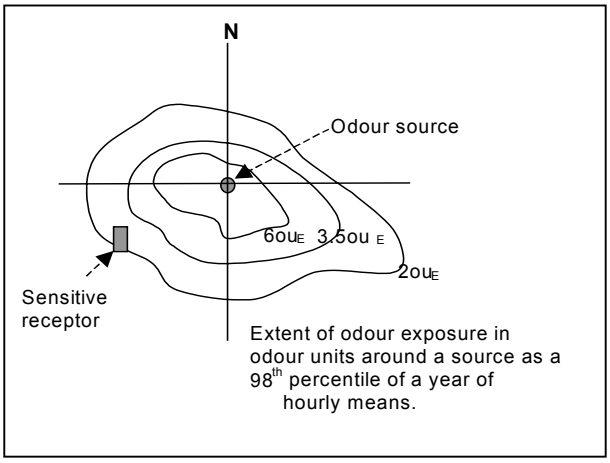
- You have failed to control odour sufficiently using housekeeping measures and consequently need to fit abatement equipment. An impact assessment will help to determine the efficiency required of the abatement system. The Agency officer will advise on this.

In all other cases you will be expected to regularly walk around the farm perimeter or near to local houses to see if odour from the unit can be detected. This is a 'subjective assessment'. People who are regularly exposed to a particular smell often become tolerant to it so you should ask someone who does not spend all their time at the farm to do this.

4.1 Full odour impact assessment

There are two main steps in carrying out a full odour impact assessment:

- the odour emissions must first be measured or predicted.
- the emissions data is fed into a mathematical atmospheric dispersion model which calculates the spread of the odour around the source, taking the local weather patterns into account. (Modelling is described in Section 4.2)



The model will draw a contour plot around the source (or proposed new unit), linking points of equal ground level concentration. Local houses all other frequented areas will fall somewhere within a contour. The concentration at this point is compared to a benchmark level and it can be determined whether the concentration is acceptable or not.

Emissions can be measured, or predicted where measurement is not possible or the unit has not yet been built.

Figure 1.1: Odour contours around a source

4.1.1 Measuring emissions

The odour from pig rearing sheds is a mixture of different compounds, usually with a high concentration of ammonia. Mixtures of compounds are generally measured in terms of odour units.

Usually a few vents are selected for sample-taking. These should be representative or typical of all the other vents. The results in odour units are then extrapolated according to the number of vents.

There are two important points to note when making an assessment of emissions:

- there may be points in the rearing cycle when odour emissions are highest and particularly when sheds are cleaned out. If these emissions are not taken into account the odour impact assessment may underestimate the impact.
- It is much more difficult to make an accurate assessment of the odour emission from heaps of manure, material spilt on roadways, land spreading of slurry and manure etc. It is therefore important to minimise these activities by observing the requirements of the Farming Rules and using good management practices.

Where emissions are under-estimated by poor procedural practices in odour impact assessment and assumptions which cannot be substantiated, this may make the difference between a prediction that local residents will find the emissions from a new unit or extension acceptable and an actual situation where there is cause for annoyance.

In such circumstances the Operator may be required to take whatever abatement measures are necessary to meet his predicted exposure levels at local receptors.

IPPC guidance Note H4: Part 2 (Reference 6) should be consulted for detail on sampling and assessment techniques.

4.1.1.1 *Additional points to note relating to Pigs*

Additional points to consider when reviewing an odour assessment report relating to pigs:

- Odour emissions will vary throughout the rearing cycle and as the age of stored slurry increases. Assessments made immediately after housing has been cleaned or the collection pit emptied should be avoided.
- Many of the odour sources on a pig operation are surface sources. The methodology used to determine the odour rate should be clearly defined.
- All the results of an olfactometry exercise should be reported rather than a single averaged value.
- Where practical, the air flow rate should be measured (this may not be possible for all odour sources).

4.1.1.2 *Additional points to note relating to* Poultry

Additional points to consider in an odour assessment report relating to poultry are:

- Odour emissions vary through the rearing cycle and tend to rise towards the end. An assessment using data from a building housing birds of less than 30 days is unlikely to correlate with the actual nuisance situation.
- Odour samples should be collected at the point of emission rather than from within the building.
- All results of an olfactometry exercise should be reported rather than a single averaged value.
- The air flow rate must be measured and the number of fans in operation reported, as well as the total number possible.
- Although important in controlling odour, the moisture content of litter cannot be used to predict the odour emission rate because several other factors influence odour generation.

For poultry operations, control systems should maintain the temperature within buildings by reducing the ventilation rate, especially at night and during the winter months. As odour emission rates remain constant any reduction in ventilation rate will result in a corresponding increase in odour concentration.

Where ventilation discharges are roof mounted some apparent benefit should be gained from the upward velocity (giving momentum). In many instances such discharges have a device to prevent the ingress of rain e.g. a cowl that reduces the upward velocity. Where the ventilation is computer controlled the velocity will be dependent on the ventilation rate, which in turn will be controlled by temperature and humidity. Therefore the optimum upward velocity (≈15m/s) may not necessarily be achieved at all times.

4.1.2 Predicting emissions

When it is not possible to measure emissions, perhaps because the impact assessment relates to a proposed unit, it is possible to predict emissions by using:

- Measurements taken at a similar unit (similarity must be justified).
- Use emission factors where they are available

Odour emission factors are numerical values which can provide a substitute for measuring emissions. They are based upon assessment by olfactometry of samples from vents etc from a number of different livestock unit which has given an odour emission rate per pig/bird. They are based on limited data and are therefore very imprecise but they can be useful in providing an approximation of odour emissions which can be modelled to show estimate the predicted impact

4.1.2.1 Use of odour emission factors

To calculate the odour emissions from an intensive livestock operation the following calculation is typically used:

Odour emission = Emission rate per animal (ou/s/animal) x Number of animals

The tables below give the best emission factors currently available for pigs (Table 4.1) and poultry (Tables 4.2 and 4.3) but these may be subject to change as better data becomes available.

Health warning: these emission rates have been derived from several different studies and there can be considerable variation between farms and also on the same farm. Most of the figures given below do not reflect the increase in odour emission with increasing weight/age and should be treated as average values. It is likely that there will be adjustment to these figures as new information becomes available.

If you use lower figures for emission rates than those listed, you should supply the actual measurement data that was used to calculate your emission rates. All assumptions should be justified.

Table 4.1: Odour emission factors for pigs

Category of animal	Recommended emission factors. Emission per animal (ou_E/s)
Fatteners, conventional, partially slatted	22.5
Fatteners, restricted emitting area below slats	10
Fatteners, cooling of slurry surface below slats	11
Fatteners, flushing twice/day below slats	11
Weaners, conventional, fully slatted	6
Farrowers, conventional, fully slatted	18
Dry sows, conventional	19
Dry sows, group housing with feeding station	7
Gilts	20
Boars	20

(Source: Reference 8)

Table 4.2 and Table 4.3 give emission rates for poultry. Table 4.2 is based upon work carried out in the Netherlands as part of a long-running programme focussed on odour and ammonia emissions. The odour emission rate is determined by both the bird and the area that it occupies (so it is effect an average value over the rearing cycle).

Table 4.2: Odour emission factors for poultry

Bird Type	Housing Type	Geometric mean	Min	Max	% variation coefficient
		ou_E/s/bird			
Hens (laying eggs)	Conventional battery cage	0.69	0.17	1.32	81%
	Conventional litter system	0.26	0.08	0.52	54%
	Conventional aviary system	0.31	0.15	0.77	67%
	Low emission system, with conveyor belt litter removal and forced drying	0.35	0.2	0.76	39%
Broiler (meat)	Conventional litter system	0.17	0.06	0.36	54%
	Conventional VEA housing	0.19	0.07	0.41	66%
	Low emission system, with conveyor belt litter removal and forced drying	0.16	0.08	0.32	42%
Mature chickens (kept to produce fertilised eggs)	Conventional litter system	0.53	0.21	1.02	51%
Ducks	Conventional straw litter (indoors)	0.49	0.18	0.99	54%

(Reference 11)

Example: odour emission rates from broiler houses have been published by Clarkson and Misselbrook and are shown in Table 4.3. Site 1 had a computerised ventilation system with roof-mounted extracting fans controlled by humidity and temperature sensors within the house. The house contained 40,000 birds at the start of the crop, and was heated indirectly by oil-fired space heaters. Site 2 had roof mounted extraction fans and housed 26,000 birds before thinning at day 44. The site employed a piped heating system that allowed higher ventilation rates than normal to be used to reduce the humidity within the broiler house.

Table 4.3 is based upon measurements carried out at only two (broiler) farms, hence the uncertainties are much higher. The emission rate is given for each bird based upon its age.

Table 4.3: Odour emission factors from two broiler operations

Site	Age of birds (days)	Odour emission rate (ou_E/s/bird)	Litter moisture content, %
1	17	0.35	
	24	0.23	26
	31	0.27	35
	38	0.53	40
	45	1.6	51
2	17	0.11	15
	33	0.3	25
	43	0.27	28
	54	0.37	27

(Reference 9)

Which values should be used?

The higher of the values for the appropriate category of bird should be used to predict the impact. Some odour will arise from the cleaning and disinfection of sheds, from the removal of accumulated manure and litter, and also from fumigants used. These comparatively short lived operations will need to be considered as part of the assessment. Your choice of factor should be justified in your assessment.

4.1.3 What is an odour unit?

The threshold of detection of an odour is the point at which it is just detectable, ie it produces a first sensation of odour in an average person. The 'strength' of a particular odour is considered in terms of the number of times that a sample of the odour has to be diluted before it becomes just detectable (it is at the detection threshold). This is determined by presenting a sample to an 'odour panel' made up of a number of trained observers in a laboratory setting. The sample is diluted a number of times and the threshold of detection is the 'strength' at which 50% of the panel of observers can first detect the odour (this point is equivalent to one odour unit). The concentration of the original sample is expressed in terms of the number of dilutions or in odour units.

This process of determining strength is called olfactometry and is quite widely used as a way of 'measuring' odour when a mixture of different chemical compounds make up the smell.

Samples for olfactometry are usually collected directly from vents or above odour sources in large sample bags. In general it is not possible to collect samples at the point where people live because the sample will be too dilute to allow it to be further diluted for testing.

In very general terms:

- 1 odour unit is the threshold of detection (in the laboratory);
- 3 odour units is the point at which the smell is recognisable, ie it could be recognised as pig odour;
- 5 odour units is noticeable (faint);
- 10 odour units is a distinct smell which can be intrusive.

The amount of time that someone is exposed to the odour, its strength and the type of odour will all play a part in producing a state of annoyance. In addition, the sensitivity of any particular individual to an odour, their memories of past exposures and the timing of exposure (for example at meal times or perhaps when feeling unwell) are also key factors.

The indicative exposure criterion applied to livestock at new farms is:
3 ou_E m^{-3} as a 98th percentile of a year of hourly means at location xyz

This means that an average concentration of 3 odour units (averaged over an hour) is to be met at a specified location for 98% of the time, as indicated by modelling.

4.2 Dispersion modelling

Where the odour emission rate from a source is known by measurement, or can be estimated, the odour concentration in the vicinity can be predicted by means of dispersion modelling.

A dispersion model attempts to describe the effects of atmospheric turbulence on the emission(s) as they undergo dilution and dispersion in the environment between the source and receptors. Concentration is one of the factors that determine the impact of a given odour on sensitive receptors.

The modelling of odour is still a developing field when compared to other pollutants. A range of different models have been used for odour modelling and all have a number of common features, but there are differences in the way that data is dealt with between the older gaussian models and the new generation models such as AERMOD and ADMS.

To visualise the extent of odour impact it is useful to produce contour plots showing odour concentrations around the source or highlighting where concentrations exceed the appropriate exposure criterion as shown in Figure 1.1.

IPPC guidance Note H4: Part 1, Appendix 4 covers the subject in more detail and proposes a 'recommended' approach to odour modelling aimed at bringing about consistency of approach. There may be circumstances in which there is a valid reason for taking a different approach and the proposed parameters do not exclude this, provided that the methodology is described and justification given. The ventilation rate from livestock units is generally higher in summer months (and this is when the potential to cause annoyance is highest as people are outside more, windows open etc). In winter however the ventilation rate is lower but the odour concentration is likely to be higher. It would be best practice to use winter rates for establishing 'worst case' in terms of odour impact.

Given the range of factors that can affect odour emissions and the difficulty in controlling them, it is not possible to obtain a truly representative estimate of the odour emission from a small number of collected samples either from a poultry house or pig sty. At best, such measurements will provide a snapshot of the conditions on the day(s) when the samples were collected. Because of this uncertainty it is good practice to consider the impact of the 'worst case' situation rather than the 'average' situation.

4.3 Subjective assessment 'walk-around'

This type of assessment does not involve measuring or predicting emissions; instead it relies upon a subjective assessment of whether odour is present or not, and how strong it is.

This assessment can be carried out at specific points (such as local houses), or around the perimeter of the unit. It can be undertaken on a daily basis, or when the wind is in a particular direction which carries the odour to local receptors. Some activities (such as cleaning) will increase the odour emissions and the effect of this on odour exposure of those nearby should be assessed using the same assessment technique. The exact requirement will vary from place to place and the Agency officer will advise as regards the best arrangements.

It is important to remember one odour unit is just detectable by 50% of a trained panel of observers in a laboratory setting. Outside of the lab the point of detection may well be several odour units.

For the purposes of a subjective assessment, it is suggested that a scale of increasing odour is used, such as:

1 No detectable odour
2 Faint odour (barely detectable, need to stand still and inhale facing into the wind
3 Moderate odour (odour easily detected while walking & breathing normally)
4 Strong odour (strong but bearable)
5 Very strong odour (very offensive, possibly causing nausea, particularly if not accustomed to this odour)

You should spend at least 3 minutes at the point(s) nearest to housing and, if odour is detectable you should consider which of the following best describes the extent of the odour:

1 Local & transient (only detected on the unit or within the farm boundary during brief periods when wind drops or blows)
2 Transient as above, but detected outside of the boundary
3 Persistent, but fairly localised
4 Persistent and pervasive up to 50m outside the unit boundary
5 Persistent and widespread (odour detected >50 m from the boundary)

The results (1-5 for intensity and 1-5 for extent) should be recorded against the date and the appropriate monitoring location. The name of the person undertaking the assessment should be recorded. The wind direction and the speed should also be noted using the following scale:

Force	Description	Observation	km/hr
0	Calm	Smoke rises vertically	0
1	Light air	Direction of wind shown by smoke drift, but not wind vane	1-5
2	Light breeze	Wind felt on face; leaves rustle, ordinary vane moved by wind	6-11
3	Gentle breeze	Leaves and small twigs in constant motion	12-19
4	Moderate breeze	Raises dust and loose paper; small branches are moved	20-29
5	Fresh breeze	Small trees in leaf begin to sway, small branches are moved	30-39
6	Strong breeze	Large branches in motion; umbrellas used with difficulty	40-50
7	Near gale	Whole trees in motion; pressure felt when walking against wind	51-61

It is also possible to draw contour plots based upon detectability but in this case the 'measuring' points must be spaced in a grid pattern across the unit and surrounding area (as near as possible). The positions or relative positions of the points must be known so that points of equal strength can be joined together with the source as the centre of the plot.

4.4 Odour Impact Assessment Reporting – full assessment

4.4.1 Overview

The following is a summary of good practice in terms of reporting protocol and should allow confirmation that the scope and conduct of the work has been competently handled and reflects the variability in odour emissions.

4.4.2 What should a report cover?

Each assessment will be different and farm-specific but there are a number of common features which should be covered in a well-planned and executed survey.

Unless the assessment is deliberately targeted at specific events only, it is usual to consider both 'normal' operation and also 'worst case'. Worst case covers operations such as cleaning out the animal houses. When carrying out an assessment to predict the impact of a new installation or an extension to an existing one it is important to make sure that these particularly odorous operations are included.

The report may also make recommendations as to the possible measures that could be taken to achieve BAT, both in terms of housekeeping and other management practices, and options for odour reduction by the addition of end-of-pipe abatement equipment.

The aspects which should be addressed during the survey, and reflected in the final report, can be broadly categorised as:

- Summary of findings;
- A description of the process, its throughput and location;
- A statement of the objectives of the survey;
- A description of the methodology used for sampling and analysis;
- A description of the installation-based work actually undertaken;
- Monitoring results;
- Interpretation of the results and conclusions drawn;
- Recommendations and discussion.

For each aspect, the following would be expected:

i) Summary of findings

ii) Process description and 'scene-setting'

The following should be included, as appropriate:

- The location of the unit in relation to the nearest sensitive sites (usually dwellings);
- A diagram of the layout and/or map showing the relative positions of the animal houses and the nearest houses;
- A description of the process - including the number of animals and techniques in used to minimise odour. A description of the nature of the buildings and the ventilation system or other containment such as slurry tanks or stores should be given, if appropriate;
- A description of the nature of the odour problem and the typical rate of occurrence;
- Complaint history - numbers, quantity, duration, frequency, any pattern or trends;
- The location and nature of any other potential odour sources in the locality:
- A description of any work previously undertaken with respect to the odour issue - perhaps previous survey work or actions taken to mitigate odours and the success or failure of such measures

iii) A statement of the objectives of the survey

iv) A description of the methodology used for sampling and analysis

A description of the main features of any standards or other methodologies used:

NB: Where olfactometry is undertaken, the guidance given in the CEN draft Olfactometry standard, (Reference 7), should be followed and all departures from the procedures described should be justified and recorded.

- A description of the equipment used for sampling and analysis;
- An estimate of error associated with both sampling and analysis.

v) A description of the activities going on when the samples were taken

It is usual to consider 'worst case' when carrying out an odour impact assessment. This will entail taking samples at an appropriate time relative to the work being undertaken to account to any variation in emissions in order to avoid 'averaging' the peaks.

The report should detail:

- Sampling locations;
- Flow rates, gas temperature etc and how these were measured;
- Sampling times;
- An explanation of why the particular sampling points and sampling times were chosen;
- Process activities whilst the work was being undertaken;
- Any arrangement made for dilution of wet or hot gases and the extent of the dilution;
- Weather conditions on the day of the survey and wind direction, strength.

vi) Analytical results

- Raw data should be given. Lack of raw data prevents checking or validation of the scope of the assumptions made;
- Time elapsed between sampling and assessment;
- For olfactometry, a description of the panellists, i.e. local or supplied by testing laboratory;
- Any deviations from standard analytical/assessment methods;
- Details of the quality assurance provided by the testing laboratory.

vii) Interpretation of the results and conclusions drawn

See Appendix 4 of Reference 4 for information on recommended parameters for dispersion modelling of odorous emissions.

- Dispersion modelling - which model was used and its suitability for assessment of odorous emissions;
- A description of the data that was input to the model to account for topography and buildings, meteorology etc for each run. State the origin of the meteorological data obtained and which area it relates to and why it is applicable to the particular assessment. (Wind directions given by met stations would generally relate to open land). Care is needed in applying the frequencies directly to mixed terrain, hills, valleys etc.
- Any local features of the local topography which a likely to produce more frequent inversion conditions or other meteorological 'quirks' should be described;
- A statement of any assumptions that have been made with respect to use of any emission factors or other predictions used in place of sampling, or to any other aspects of the release;
- The results for each run of the dispersion model should be given together with an interpretation in terms of the effect on the local environment;
- Maps, figures and contour plots used to illustrate the extent of odour impact, including identification of specific sensitive receptors.

viii) Recommendations and discussion

This will obviously and be strongly influenced by the nature and purpose of the survey and may cover:

- An estimation of the likely impact of current or predicted emissions on sensitive receptors
- An estimation of the amount by which emissions will need to be reduced to avoid causing annoyance
- Suggested changes to activities or buildings;
- Relevant control technology and costs if available;
- Measures to be employed to monitor the effectiveness of any changes made.

The above is not exhaustive but should be provided as a minimum (where relevant to the purpose of the survey) by a competent contractor or survey team.

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