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SCOTTISH GOVERNMENT

SEPA
Scottish Environment Protection Agency

Odour guidance 2010

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Important note

This guidance is intended for specific internal SEPA use only. It could change because of changes to legislation, future Scottish Government guidance or experience in its use. In the interests of transparency this guidance may be made available to non-SEPA staff, but it has no status other than internal guidance to SEPA staff. It contains simplified guidance based on complex legislation which is subject to change and does not constitute legal advice. SEPA cannot be held liable for any errors and omissions in this guidance. Compliance with the law remains the responsibility of operators. If operators have concerns over compliance, they should seek professional advice or contact their regulator.

Contents

Introduction

The Scottish Environment Protection Agency (SEPA) is Scotland's environmental regulator. Our aim is to provide an efficient and integrated environmental protection system for Scotland that will help to improve the environment and contribute to the Scottish Government's goal of sustainable development. We use regulation to protect and improve the environment, which means we are responsible for issuing environmental licences and permits across a wide variety of activities. The conditions of licences and permits are set to minimise the risk of harm to the environment and human health.

Protecting the environment from pollution[1] resulting from the release of odorous substances is one of the most challenging aspects of our work. The assessment and identification of this type of pollution can be subjective and the impact highly variable. These factors all contribute to the challenge for SEPA to be a fair and proportionate regulator whilst at the same time ensuring that the interests of affected people are protected.

This guidance applies to both licensed and unlicensed activities (see Part 4) that fall under the relevant legislation, but there is an emphasis on ensuring compliance with environmental licences. It is acknowledged at the outset that certain activities are likely to produce odours from time to time.

This guidance is intended to support our regulatory activities including licensing and enforcement actions (as specified in our enforcement policy). Any response by SEPA to an odour complaint, or any potential odour release from a SEPA regulated activity, has to be consistent with our enforcement policy.

This guidance should be taken into account when considering the grant or review of an environmental licence for activities that may give rise to the release of odorous substances; in particular to ensure that adequate controls are in place to avoid significant pollution as a consequence of the release of odorous substances.

Aims

This guidance has been provided for SEPA officers engaged in regulating potentially odorous activities. This document aims to provide practical guidance on how and why odours occur, how they can be investigated, how they can be mitigated and the roles and responsibilities of SEPA.

The field of odour measurement and control is very wide in scope and is continually developing. This guidance has been prepared after reviewing a number of key information sources such as national guidance in the UK, Europe and the rest of the world. It aims to make use of best practice in the control and approach to the regulation of emissions of odorous substances from activities we regulate. It may therefore be reviewed and updated as required.

Regulatory frameworks for addressing odour

There are several industrial, agricultural and domestic activities that can give rise to odours. SEPA has a remit to regulate the emission of odours from industrial and agricultural activities if they are subject to controls under the Pollution Prevention and Control (Scotland) Regulations 2000 (as amended) – known as "the PPC regulations" – or Part II of the Environmental Protection Act 1990, which is the waste management licensing regime and is known as "Part II of EPA90". Together these pieces of legislation are referred as "environmental legislation".

[1]Depending on the regulatory regime "pollution" and "pollution of the environment" have specific legal definitions. Reference must always be made to the specific definitions in the relevant legislation.

PPC Regulations: Part A (IPPC)

Integrated Pollution Prevention and Control (IPPC) is a regulatory system which takes an integrated approach to control the environmental impacts of certain prescribed industrial activities. The activities covered include major process industries, waste management and the intensive farming of poultry and pigs. IPPC requires that installations are operated in such a way that all appropriate preventative measures are taken against pollution, in particular through the use of Best Available Techniques (BAT), to prevent or minimise emissions from their activities. "Emissions" includes the release of odorous substances to air. IPPC is implemented in Scotland through the PPC regulations and all onshore installations in Scotland covered by the PPC regime are regulated by SEPA. The PPC permit can specify design and control measures for odour management. Permits are regularly reviewed to ensure they reflect current BAT.

PPC Regulations: Part B

More commonly referred to as Part B installations, these are also regulated under the PPC regulations making use of the same controls as applied to IPPC or Part A processes except these only apply to emissions to the air, including the release of odorous substances. As with Part A above, Part B PPC permits can specify design and control measures for odour management permits are regularly reviewed to ensure they reflect current BAT.

Part II of EPA90 (waste management licensing)

The aims of the Waste Management Licensing ("WML") regime under Part II of EPA90 and the Waste Management Licensing Regulations 1994 include ensuring that waste is recovered or disposed of without endangering human health, and without causing nuisance through odours. Many sites previously subject to WML, such as larger landfills and waste treatment facilities, have recently moved over to the PPC regime. Sites remaining in the WML regime are required to hold licences or operate under an exemption in accordance with the Waste Management Licensing Regulations 1994.

The EPA90 provides it is an offence for a person to treat, keep or dispose of controlled waste in a manner likely to cause pollution of the environment or harm to human health.

For the purposes of EPA90, "pollution of the environment" includes pollution of the environment due to the release or escape into any environmental medium from land where controlled waste is treated, kept or deposited of substances or articles constituting or resulting from the waste (and capable by reason of the quantity or concentration involved) of causing harm to man or any other living organisms supported by the environment. "Harm" for this purpose means harm to the health of living organisms or other interference with ecological systems of which they are part and in the case of man includes offence to any senses or harm to property (Section 29 in EPA90).

The Waste Management Licensing Regulations 1994 (as amended) place a duty on SEPA to perform our waste management licensing and waste regulation functions (under EPA90 and the WML regulations) in accordance with "relevant objectives". These include:

> "Ensuring that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment and in particular without:
>
> (i) risk to water, air, soil, plants or animals; or
> (ii) causing nuisance through noise or odours; or
> (iii) adversely affecting the countryside or places of special interest.
> Schedule 4, paragraphs 2(1) and 4(1)] of the WML regulations

Any establishment or undertaking purportedly disposing of or recovering waste under an exemption under the WML regulations is also subject to an overriding obligation to comply with the relevant objectives (Regulation 17 [4]).

Further details on SEPA's functions and the legislation we enforce can be found at: www.sepa.org.uk/about_us.aspx

Emissions of odours from other sources such as sewage works not subject to the PPC regulations or the WML regime are regulated by local authorities under statutory nuisance provisions.

Statutory nuisance

Local authorities rather than SEPA regulate statutory nuisance under Part III of EPA90. The definition of statutory nuisance in this act includes an odour arising from industrial or commercial premises which is prejudicial to health or a nuisance. The provisions require a local authority to investigate any complaints of statutory nuisance and also to inspect their area from time to time to identify any potential statutory nuisances which ought to be dealt with.

If the activity is regulated under the PPC regulations, SEPA may deal with nuisance issues arising if the nuisance relates to the regulated emissions. In circumstances where SEPA is able to take action under the PPC regulations in respect of a matter constituting a statutory nuisance, the local authority needs the consent of the Secretary of State if it wishes to institute summary proceedings for statutory nuisance under Part III of the EPA. This is in order to prevent dual regulation.

Please see the referenced materials section below for information on the case of odour nuisance arising from waste water treatment plants, which would be handled by the local authority under statutory nuisance powers.

Planning

Before any new or altered activity is undertaken there is normally a requirement for the operator to obtain relevant planning permissions under the Town and Country Planning Scotland Act 1997 which specifies controls over new or changed developments. The planning system has an important role in preventing or minimising odour impacts from new or changed developments by regulating the location and, to a certain extent, the specification of some design and control parameters of these activities. SEPA is a consultee for most planning applications and is a statutory consultee for larger developments subject to the requirement to undertake environmental impact assessments. If SEPA is the regulator of an activity under environmental legislation, we will advise the local authority accordingly and highlight any potential issues associated with the activity including for example, its potential to give rise to odour.

More information on the planning regime in Scotland can be found at: www.scotland.gov.uk/Topics/Planning

Part 1: The general fundamentals of odour

1.1 What is an odour?

Odour is perceived by our brains in response to chemicals present in the air we breathe. Odour is one of the effects that those chemicals have on us. Humans have a sensitive sense of smell and can detect odour even when chemicals are present in very low concentrations.

The subject of odour is a highly complex one and the response of an individual to odour exposure is highly subjective: their reaction will depend on issues such as how strong it is, what it smells like, how often and when it occurs and in what context.

The following characteristics can further complicate the assessment of odours:

- An odour can arise from a single substance or from a combination of substances.
- In combination with other substances, the characteristic odour of a single substance can be modified so as to be unrecognisable.
- Odour changes as the mixture becomes diluted. Individual components may fall below their odour threshold.
- Odours from a substance or mixture of substances can be pleasant when dilute but offensive when concentrated.
- Odours that are pleasant or acceptable to one person can be offensive and unacceptable to another individuals can have different sensitivities to odour.
- Many assessment methods are subjective.

1.2 Effects and health impacts of odour

The main concern with odour is its ability to cause an effect that could be considered 'objectionable' or 'offensive', resulting in annoyance, nuisance or actual harm. An objectionable or offensive effect can occur either where an odorous compound is present in very low concentrations, usually far less than the concentration that could harm physical health, or when it occurs in high concentrations.

A wide range of symptoms are experienced by people exposed to offensive odour including vomiting, respiratory problems, nausea, drowsiness, fatigue, eye complaints, nose and throat irritation, hoarseness, headache, diarrhoea, chest tightness, nasal congestion, palpitations and shortness of breath. Health effects such as headache and nausea can have a significant impact on a person's daily activities and the long-term effect of such symptoms is unknown. It is clear that these symptoms can arise at concentrations well below those associated with toxic effects or thresholds for mucus membrane irritation, but are at olfactory detectable levels.

The human response to odour can be affected by pre-disposed psychological and social factors, including susceptibility. The severity of symptoms is also related to a person's level of concern about the potential harm of the odour to their health, suggesting there is a high psychological influence on the manifestation of any physical symptoms[2]. There is a strong correlation between perceived odour annoyance and subjective symptoms but little to link odour to objective measures of psychological change.

Variability in susceptibility to detectable odour is one of the major reasons affecting any action taken to address odour problem. Two aspects of variability are linked to conditions called "chemical odour intolerance" and "multiple chemical sensitivity". "Chemical odour intolerance" is a condition where "chemical smells" trigger symptoms in affected individuals. Such people have a greater tendency towards anxiety than the general population, but no clear criteria exists on which a prediction of chemical odour intolerance can be based.

[2]Health Impacts of Odour (AEA Reports on behalf of SEPA) See References.

"Multiple chemical sensitivity" is related to a condition that affects a minority of people with chemical odour intolerance. Pregnant women are particularly susceptible to the effects of odour with exposure being associated with an increased risk of nausea and vomiting. Other susceptible sub-populations include elderly persons and people with asthma or other respiratory illnesses. Children, as a result of their small body weight and developing respiratory system, are also classified as a susceptible sub-population.

Prolonged exposure to an odour can result in people becoming desensitised so that they can no longer detect the odour despite the odorous chemical being constantly present in the air. Conversely, individuals may become sensitised to olfactory stimulants through acute exposure events or as a result of repeated exposure to nuisance levels of odours.

Appendix 1 provides technical data on reported thresholds for both odour detection and the health effects of individual compounds. Various chemicals may combine (chemical mixture) to exacerbate the health effects or odour annoyance which would otherwise be caused by individual compounds.

SEPA staff can obtain further advice on health effects from SEPA's Human Health Intranet site or via the Human Health Helpdesk.

1.3 Why assess odour?

The effects of odour emissions are assessed for a wide range of reasons, including investigating complaints and determining licence applications. The amount and type of information required for an assessment depends on the circumstances of the odour discharge and the reason for undertaking the assessment. Usually the aim of the assessment is to determine the source of the odour and whether it is offensive and objectionable, therefore causing adverse effects on the local community.

Odour assessments can generally be categorised as being needed for one of six reasons:

- considering environmental impact assessments and planning applications;
- determining environmental licence applications;
- reviewing an existing environmental licence;
- monitoring compliance with environmental licence conditions;
- investigating odour complaints or incidents;
- taking enforcement actions as necessary.

1.4 What is an offensive odour?

Environmental legislation enforced by SEPA provides various definitions of pollution[3]. In the context of PPC or EPA90, odour can be considered to cause pollution by causing offence to human senses or harm to human health or harm to the quality of the environment. An understanding of what is offensive is critical to effectively regulate facilities under these regimes which can give rise to the release of odorous substances.

The key to understanding the principle of an offensive odour is that the mere presence of an odour does not necessarily mean that it is offensive. The characteristics of an odour that are taken into account when assessing its offensiveness are Frequency, Intensity, Duration, Odour Unpleasantness, and Location; sometimes described by acronym FIDOL.

[3]Definitions provided in the glossary

Frequency	How often the exposure occurs
Intensity	The perception of the strength of the odour
Duration	The length of any particular odour event or length of time exposed to the odour
Odour unpleasantness (Relative offensiveness)	The character of an odour as it relates to its hedonic tone (pleasant, neutral or unpleasant) at the a given odour intensity
Location	The type of receptors eg housing, play areas, areas of particular sensitivity etc and also local meteorological conditions

When assessing the levels of polluting substances necessary to avoid harm to health it is usual to determine appropriate numerical values for such limits. In the case of odour, the response of the human nose means that each individual will make his or her own subjective assessment as to whether the odour is offensive and whether it is acceptable. As stated above, odour can be detected at very low concentrations, often at or below the sensitivity of environmental sampling and analysis techniques currently available.

Whilst it is possible to measure the odour concentration using a standardised method (dynamic olfactometry as detailed in BS EN13725), it is more difficult to quantify the offensiveness of the odour. Where numerical rankings are used to try and simulate the sensory annoyance, they still rely upon subjective analysis and hence standardisation is almost impossible. In general, odour effects are not caused by one single pollutant or chemical species: odour is often a 'cocktail' of chemical species emitted from a process.

The nose is an extremely sensitive odour receptor - it can respond to small variations in odour over periods of a few seconds and at concentrations of fractions of a part per billion. There are many factors that influence the perception of an odour, including variations due to the subjectivity of the receptor, dispersion of odour due to local meteorological conditions and variations in the generation of odour due to raw materials and cycle operations used in the process. In general, there is very little difference between the offensiveness of an odour and its potential to cause nuisance. The assessment of offensiveness of odour remains a subjective sensory olfactory response of observers. However, all odours have the potential to be offensive and cause annoyance.

Recent studies[4] suggest that the perception of the intensity of odour in relation to the odour concentration is not a linear but a logarithmic relationship. Interactions between mixtures of odorous compounds can also occur. These are known as synergistic effects.

All of the above factors must be considered when determining whether or not an odour is offensive, and in the context of PPC or EPA this is referenced to an "offence to human senses". It is important to realise that, given the subjectivity of offensiveness, an assessment of odour impact must be made in a systematic manner detailing observations made at the time of the assessment. This guidance provides methods to assess the nature of an odour. In some cases more than one method may be required to come to a conclusion.

The H4 draft guidance document provides a benchmark criterion of "no reasonable cause for annoyance" to establish the point at which an odour impact becomes unacceptable. That point was established in studies[5] undertaken in other countries as being the point where the majority of an affected population would not find the odour to be unacceptable. For modelled releases, this point was established where odour in the air was estimated to be higher than a suggested level based on a 1 hour average for 98% of the time. This provides a reasonable basis to inform the design of new installations or the required upgrading of existing facilities but it does not address the issue of the proportion of an affected community which may be more sensitive to odour than the normal population.

[4]EA report SC030170/SR2 Review of odour character and thresholds
[5]Assessment of community response to odorous emissions – R&D Technical Report p4–095, undertaken for the Environment Agency by OdourNet UL ltd.

The Environment Agency compliance incident classification scheme provides descriptors of potential impacts from the release of odorous substances and associated actions to be taken by local inspectors. This system provides benchmarks for taking action in particular situations and does not rely on any particular frequency but instead on the impact that arises from the odour. In conjunction with SEPA's own classification scheme[6] elements of the Environment Agency's expanded scheme have been adopted by us for dealing with odour incidents and details can be found in Part 4.

There is no clear benchmark for assessing an odour for offensiveness. For some people even otherwise pleasant odours may cause offence. Similarly no one method for assessing offensive odour has been established which would cover all eventualities. Part 2 of this guidance provides methods and assessment benchmarks that can be used to assess whether or not any proposed activity is likely to give rise to significant pollution or cause nuisance through odour. Part 3 of this guidance provides advice on regulating operational sites while Part 4 provides advice on responding to and taking action in the event of odour being detected beyond the boundary of a site.

1.5 Parameters associated with odours

1.5.1 Odour units

This parameter is frequently encountered in the field of odour measurement: in simplest terms, it is the amount of dilution required to bring a specific species (or species group) of chemical in a given air sample to its detectable threshold. The greater the amount of dilution required, the more odorous the sample and the lower the odour threshold. The analysis is performed by a selected human panel and the result is presented as $mg.m^{-3}$ (for pure single substance samples) or European Odour Units $OU_E.m^{-3}$. Many publications carry tables of odour thresholds for single substances but there is often conflict between these and often the threshold is reported as a range rather than a specific number. Comparing a chemical quantification to the odour threshold of a simple one to two species odour can be somewhat effective, but as the chemical mix of the odour becomes more complex, the odour threshold of specific components is of little use.

1.5.2 Hedonic tone

Hedonic tone is a somewhat arbitrary and subjective term in many ways. Essentially a panel of human assessors is exposed to a given sample and asked to rank it on a scale. There are a number of scales used but for the purposes of this guidance the +4 (pleasant) through zero (neutral) to -4 (unpleasant) scale will be referred to and is provided in Appendix 1.

1.5.3 Odour characterisation

Odour is often characterised using a list of standard descriptors which can vary between countries and even between different laboratories within a country. Generally speaking, a panel of assessors are exposed to an odour and asked to describe it in terms of a given list of adjectives (eg floral, fishy, earthy etc) and assign it an intensity on a predetermined scale such as hedonic tone. Descriptions of some common odours are provided in Appendix 1.

1.6 Monitoring odours

This section summarises techniques available for the "quantification" of odour in air as it relates to the investigation of offensive emissions from industrial installations. Odours will generally fall into two distinct groups: chemical and biogenic-organic. In general, the available techniques can be broken down into two different approaches: sensory and chemical techniques. The appropriate technique essentially depends on the objective of the exercise and the likely chemical cause of the odour. It is strongly advised that specialist advice is taken before undertaking monitoring for odours: SEPA staff can obtain advice from the Field Chemistry Unit.

The quantification of offensive odour is often inherently difficult because it seeks to relate concentrations of chemical species in air to human sensory perception. For the most part, members of the public will not complain about a specific compound but of a generally foul odour. Most such complaints will arise from biogenic sources eg animal rendering, fish processing, maggot farming and distillery dark grains plants. In cases such as these, the odour is invariably made up of a cocktail of dozens of different compounds which vary in concentration over time; it is essentially impossible to strictly quantify these on a chemical concentration basis and often, attempting to do so leaves resolution of the problem no nearer. In these cases, sensory methods are often (but not always) the best approach.

[6]SEPA's classification scheme can be found in Table 2, Page 13 of SEPA's *Compliance Assessment Scheme Guidance Manual*

At the other end of the spectrum, some processes will be known to emit a very few simple malodorous species eg specific chemical synthesis installation, brickworks. In these cases, chemical quantification can be useful, especially because several of the species may come directly under the remit of specific air quality regulations.

1.6.1 Chemical quantification

The advantage of chemical techniques is that specific odours can be quantified and compared to known air quality limits (or, alternatively, published odour thresholds for individual species).

"Chemical" odours cover atmospheric releases of small, easily identifiable odour-causing molecules. Examples of this include sulphur dioxide release from liquid and solid fuel combustion or brickworks, toluene from print works and styrene and 1,3-butadiene from synthetic rubber production. Other discrete molecules which may be quantified include ammonia, hydrogen sulphide and formaldehyde. In these instances, it is preferable to attempt to directly quantify the identified species by conventional chemical/analytical methods because doing so allows comparison against authorisation conditions (in the case of stack/source monitoring) or legal air quality standards (ambient monitoring). Recognised monitoring techniques are readily available for use in these situations. This is by far the simplest (and rarest) scenario encountered during odour investigations.

"Biogenic-organic" odours cover a multitude of processes where organic material is being processed in some manner. The nature of these processes is such that the exact chemical composition of the odour is highly unlikely to be well characterised beforehand and is likely to consist of dozens of chemical species of different classes present at different (and temporally varying) concentration. Some very limited chemical characterisation can be attempted in such situations: in terms of stack monitoring, the CEN standard BS EN 13649 may be applied: This technique involves withdrawing a sample of gas from the stack onto absorbing tubes which are then transferred to an analysing laboratory for desorption and gas chromatography (GC-MS or GC-FID) quantification. A similar approach can be taken in ambient monitoring, using either active or passive absorbing tubes.

Both techniques have severe limitations however: the choice of absorbing material determines the class of compound which is most efficiently trapped ie some knowledge of the species of interest is required beforehand. In stack monitoring, hot, wet gas streams are often problematic in terms of pollutant condensation and loss. Additionally, the analysis of the species present is almost invariably done by library-matching the GC-MS/FID results ie it is semi-quantitative because the absolute quantification requires extensive validation and the purchase of numerous standard materials. Finally, the results of such an exercise will likely yield a long list of many organic compounds of different classes. For example, such an exercise undertaken at a distillery dark grains plant detected over forty species including aldehydes, ketones, mercaptans, alcohols, hydrocarbons and organic acids: some of these were over the odour threshold, some under. It is highly unlikely that any one particular species could be identified as the cause of the odour because there will be a collective effect of all species to produce the odour. For these reasons, biogenic odours are best approached with sensory techniques.

1.6.2 Sensory techniques: dynamic olfactometry

The biggest advantage of sensory techniques is that they provide a direct link between the odour and human perception. The disadvantages are that it is necessarily labour intensive and not continuous. In addition, sampling from sources is generally performed by means of pumped extraction of a gas stream into a Tedlar bag and therefore the problems associated with hot, wet gas streams also apply, but they can be overcome to a certain extent using either static or dynamic pre-dilution.

The relevant standard method for olfactometry is BS EN 13725 *Air Quality – Determination of odour concentration by dynamic olfactometry*. This method is used throughout Europe, replacing many earlier national standards.

The unit used in olfactometry is the European Odour Unit, $OU_E.m^{-3}$. This is defined as the amount of odorous species that, when evaporated into 1 cubic metre of neutral gas at standardised conditions, elicits a response (detection threshold) from a panel equivalent to that elicited by one European Reference Odour Mass (EROM) under the same conditions. The reference substance used is n-butanol. One EROM of n-butanol is 123µg.

The test itself involves a selected panel of assessors and is conducted on a dilution rig. The testing philosophy is that of triangular forced choice ie each panel member is confronted with three "sniffing ports" one of which is the

diluted sample, whilst the other two are neutral gas. The panel member must then make a yes/no choice as to which port is the active diluted sample port. Successive dilutions of the sample are presented to the panel members and a complex statistical calculation made to determine the final result, which attempts to take into account the natural variability of human response.

Although slightly cumbersome, costly and labour intensive, this method remains the only reliable way of actually assigning a numerical value to a complex odour. This approach has been used to a relatively limited extent in a regulatory sense, as described in the two examples below.

An industrial premises boundary or receptor limit is set in terms of $OU_E.m^{-3}$ (generally on the 98th percentile). The precise value of this limit is determined according to the nature of that odour ie the greater the potential for nuisance and loss of amenity from a particular odour, the lower will be the appropriate limit (see Draft H4 Guidance on Odour dated 2002) for examples of limits for various industrial processes: note these are essentially empirical in nature). A dispersion modelling exercise is then conducted using the actual emission rate in OU_E/s as determined from dynamic olfactometry testing from an enclosed source eg a chimney stack. An atmospheric dispersion model is run to assign a limit value to the stack source ($OU_E.m^{-3}$) so that the boundary/receptor condition will not be breached in the worst case dispersion conditions. It must be emphasised that this is a complex exercise, only applicable to emissions from ducted sources such as stacks and is not readily applicable without careful consideration to area and fugitive sources, due to the uncertainties in modelling such releases. Ambient dynamic olfactometry cannot be used because the value for ambient air can be up to 100 $OU_E.m^{-3}$. This exercise determines the additional odour contribution over and above the background level to the odour at the downwind point which can be attributed to the original source.

Olfactometry can also be used to determine the operational efficiency of odour abatement equipment. This will typically involve the olfactometric evaluation of a gas stream before and after the abatement unit(s). Minimum operational percentage efficiencies may then be applied to the equipment. This approach can be useful in determining whether or not abatement is being maintained and is effective. It should be noted that during some operational plant conditions, chemical reactions within abatement plant can actually result in the treated gas having a higher odour concentration in $OU_E.m^{-3}$ than the raw gas. In both given examples, it must be noted that several practical considerations may exclude the use of olfactometry, most commonly, lack of suitable sample ports and platforms and potential sample degradation due to wet, hot gas streams resulting in condensation. Another potentially confounding factor can be encountered when applying olfactometry based methods to processes which are highly variable in nature eg installations which process a wide variety of materials.

1.6.3 Sensory techniques: field testing/investigation

Often, when dealing with potential offensive odour complaints, SEPA officers will receive a communication from a member of the public which will require an immediate response in order to investigate and/or verify the justification for the complaint. In such circumstances it is unlikely that instrumental techniques or procedures to initiate a dynamic olfactometry will be available within the required timescale. In such circumstances, a sensory field test (often referred to as a "sniff test") is generally the most appropriate approach.

The principle of a field test is relatively simple: first, the officer will visit the area of the complaint. Assuming they can identify the likely source of the odour (from local knowledge, information gleaned from the complainant etc), the officer should then identify several testing locations, typically some upstream and some downstream of the suspected source. The exact number and location of the testing locations depends on the topographical area and the likely receptors. At each location, the officer should use their olfactory sense to assign a scaled numerical attribute to any odour encountered, typically a description of the odour, its intensity and persistence. Basic meteorological conditions should also be noted (eg air temperature, wind speed and direction, pressure, precipitation etc). Finally, any other relevant supporting information should also be recorded: typically this will include any confounding factors, unusual operating conditions at the suspected installation and sensitivity of the testing location.

Field testing can be used in conjunction with other techniques on a long term, scheduled basis in order to build up a profile of the location. Further guidance on the details and suggested procedural approaches is provided in Part 4 of this guidance.

Part 2: New or changed facilities

2.1 Planning consents

Planning authorities play the key role in land use decisions such as the suitability of locations for industrial facilities which could result in the release of odour. The application for planning consent is often the first opportunity SEPA has to make our views formally known to the applicant and to the wider community regarding a proposal to build and operate a facility that may give rise to offensive odour. Some industrial trades are inherently odorous by virtue of the materials they process, generate, use or store. Any response to a planning consultation should acknowledge that, even with the use of best industrial practice, from time to time such facilities may give rise to offensive odour. In some circumstances the ability to adequately disperse the release of offensive odour may be limited so that a local community may be effected to a lesser or greater degree. Responses to planning consultations should be comprehensive and clear to ensure that the planning authority is made fully aware of potential problems with particular activities that by their nature or proposed location may give rise to offence arising from the release of odorous substances. Such interventions may serve to influence planning authority decisions and help to ensure that planning permission should not be granted for facilities in inappropriate locations.

An application for planning consent is often made before any application for an environmental licence to operate. This can result in a lack of information in a planning consultation, making it necessary for SEPA to come to a considered view on the likelihood of a release of odour. Applicants/operators should provide sufficient information and should consider submitting applications for planning consent and any required environmental licence at the same time. It is recognised that in some circumstances the information available at the planning stage may not be sufficient to satisfy the requirements of the environmental licence application, for example detailed design is incomplete. At a minimum, the planning application must provide the necessary information to inform SEPA about key environmental matters – including the potential for odour impact.

Further guidance on SEPA's planning role can be found at: www.sepa.org.uk/customer_information/planning.aspx

2.2 Environmental licence

The general aim of any environmental licence[7] is to ensure the activity is operated in such a manner that pollution is prevented or, if that is impossible, minimised.

The initial design and construction of any industrial plant offers the best opportunity to ensure that appropriate techniques or methods are included to prevent or minimise pollution including the release of odorous substances which might be offensive or cause nuisance.

This could result in, for example, selection of different raw materials with a lower odour threshold or the identification that odour abatement equipment is required. Engaging with operators at an early stage of process design can lead to significant improvements to protect the environment and can result in more cost effective environmental protection devices which are an integral part of the design.

A critical element of assessing the suitability of proposed techniques or methods to prevent or minimise the release of odorous substances is the provision of robust and comprehensive proposals to effectively manage the operation of the industrial activity. The best designed and constructed equipment can fail if operated by poorly trained or inadequately supervised staff. Examples of techniques, including the management of odour, are provided in Appendix 4.

During the determination of an application for an environmental licence, regard must be given (subject to the requirements of the appropriate environmental legislation) to the release of odorous substances and the potential offence to any human senses or impairment or interference with amenities and other legitimate use of the environment that could occur, ie could it cause pollution or nuisance? It is for the applicant to provide the necessary information to allow SEPA to make a determination.

[7]In this guidance 'environmental licence' also includes situations where an activity is regulated by SEPA under an exemption, such as a waste management licence exemption. While exempt activities are considered to be lower risk, the guidance provided here is appropriate for ensuring that the release of odour would not result in pollution leading to, for example, a breach of relevant waste management objectives.

2.3 Assessing odour release for the purposes of determining an application for an environmental licence

Under PPC

Regulation 8(2) of the PPC Regulations specifies general principles that SEPA shall take account of when determining the conditions of a permit:

> installations and mobile plant should be operated in such a way that-
>
> (a) all appropriate preventative measures are taken against pollution, in particular through the application of the best available techniques;
>
> (b) no significant pollution is caused.

Under WML

The Waste Management Regulations 1994 (as amended) place a duty on SEPA when discharging our waste management licensing and waste regulation functions under EPA 1990 and the WML regulations to discharge them in accordance with "relevant objectives". These include:

> "...ensuring that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment and in particular without
>
> i) risk to water, air, soil, plants or animals; or
> (ii) causing nuisance through noise or odours; or
> (iii) adversely affecting the countryside or places of special interest [Schedule 4, paragraphs 2(1) and 4(1)]."

As described in Part 1, the release of odorous substances can lead to offence, annoyance, nuisance and health impacts from physiological response to unpleasant odours. The following guidance is provided to assist officers in determining applications and deciding on what conditions, if any, should be included within an environmental licence (if such a licence is to be issued) to ensure that the requirements of environmental legislation can be achieved. Examples of this are ensuring that all appropriate preventative measures are taken against pollution (for PPC permits) or that the relevant objectives (for WMLs) are included.

In order to avoid the duplication of standards between different licensing regimes this guidance provides benchmark standards and guidance for all activities that may be regulated by SEPA. The scale and extent of techniques to be adopted to prevent pollution will vary according to the specific circumstances of any activity, e.g. the nature and amount of odorous substances kept or used on site. For clarity any reference to "significant pollution" should also be taken to mean pollution or harm to human health that would be likely to lead to an application for an environmental licence being rejected.

The fundamental aim of odour control is to ensure that, where odorous substances are used or generated (ie where they cannot be avoided), they are controlled using a high level of containment, leading to well designed, maintained and operated abatement systems. Any exhaust gases must also be discharged to the air via appropriately designed chimneys etc (see D1 HMIP guidance note[8]). Fugitive and other non contained emissions should be avoided. A hierarchy of control is listed in Table 1.

[8]D1 HMIP Technical Guidance Note (Dispersion) published by HMSO ISBN 0- 11-752794 - 7

Table 1: Hierarchy of control options for odorous substances

1. Avoid using odorous substances altogether.
2. Where odorous substances are present they should be used and stored in contained systems*.
3. Where odorous substances cannot be fully contained they should be captured using local ventilations systems (eg fume hoods) and the exhaust gases suitably treated to reduce the amount of odorous substances present.
4. Where odorous substances cannot be contained or collected locally then a building or structure should be constructed, maintained and operated to offer a high level of room containment such as having sealed (air locked) working areas, room extraction with at least three room air changes per hour as a minimum and the exhaust gases suitably treated to reduce the amount of odorous substances present to a minimum.
5. Any treated gases are discharged to the air via appropriately designed chimneys.

* In this instance 'contained systems' is taken to mean that the odorous substances are enclosed such that they cannot escape to the immediate environment. It is accepted that for certain activities it is not always possible to contain odorous substances due to the nature of the activity being undertaken. Such activities may include landfill, composting (open windrows), land spreading and coating of large vessels/objects etc. In such circumstances deviation from the hierarchy is accepted, but alternative control methods must be described and their use justified. Control methods for odour from such activities are discussed in Appendix 4.

An applicant should clearly demonstrate that the proposed odour management system to be used complies with the above hierarchy. Where exhaust gases are released, or could be released, the applicant should consider whether or not that release could result in pollution (as defined in the relevant environmental legislation). This assessment should consider routine and reasonably foreseeable non-routine operational scenarios such as start up and shut down, or failure of the abatement technology eg a relief valve operating bypassing the abatement equipment. Officers determining an application should ensure that the applicant addresses these points.
Assessments should be proportionate to the likely probability of any release. All applications will require some assessment if only to discount them from further detailed assessment. The assessment should be escalating in terms of scope, detail and complexity based on the identified or suspected risks of the release of odorous substances.

For an application for an installation or a waste operation which does not handle or generate odorous substances, pollution impact from odour should be able to be screened out and need not be assessed in detail. An application for an installation handling small amounts of known odorous materials (for example a solvent) should be assessed using tools aimed at screening out insignificant impacts such as those contained in Part 1 of the H1 methodology[9].

For an installation handling materials with a high potential for release of odorous substances, a detailed assessment of the impact any release may have to be undertaken. This should, where applicable, include the use of predictive impact models such as ADMS or AERMOD.

The impact of the release of a mixture of odorous substances should be assessed against the criteria listed in Table 2.2. These odour exposure criteria are derived from dose effect studies and are published in the draft H4 2002 guidance document. The criteria describe ground level concentrations of different odour types which have been reported by those interviewed as being acceptable in the long term. Further information can be found in Appendix 6 of H4 2002. If the odour is caused by the release of a single substance then substance specific odour threshold information should be used.

The use of such criteria can also help the design of a facility and highlight areas of concern. For example they can be used as part of the D1 method to calculate the minimum chimney stack height required etc.

[9]H1 Horizontal Guidance Note : Assessment & Appraisal of BAT, Available at: http://www.environment-agency.gov.uk/business/topics/pollution/37231.aspx

Table 2: Industrial activities and indicative criteria of significant pollution note1

Relative offensiveness of odour	Indicative criterion of significant pollution note 2
More offensive odours: Activities involving putrescible wastes Processes involving animal or fish remains Brickworks Creamery Fat & Grease Processing Waste water treatment Oil refining Livestock feed Factory	1.5 OU_E/m^3 (1.0 OUE /m^3) note 3
Odours which do not obviously fall within a high or low category: Intensive Livestock rearing Fat Frying (food processing) Sugar Beet Processing	3 OU_E/m^3 (2.5 OUE /m^3) note 3
Less offensive odours (but not inoffensive): Chocolate Manufacture Brewery Confectionary Fragrance and Flavourings Coffee Roasting Bakery	6 OU_E/m^3 (5.5 OUE /m^3) note 3
Note 1: Reference: EA H4 Guidance Appendix 6. Note 2: Odour Units (OUE) as 98th percentile of hourly averages. Note 3: Local adjustment for hypersensitive populations (odour generated a high level of complaint) - Reference: EA H4 Guidance Appendix 6.	

The indicative criteria as described in Table 2 are the recommended minimum criteria to be used in assessment.

Where an assessment indicates that the criteria could be exceeded for any release scenario then an applicant should be required to undertake further investigation and make proposals for preventing or minimising that release should it occur, so that the impact is likely not to exceed the criteria. Additional applicable methods should also be used. For example, the Odour Risk Matrix Assessment Method described in Appendix 2 to estimate the acceptability or otherwise of the activity.

In situations where, despite the conditions of a permit or licence, significant pollution may be caused (PPC) or the requirements of the relevant objective are likely not to be achieved (WML), the refusal of an application should be considered (always refer to specific requirements of appropriate environmental legislation for grounds on which an application may or must be refused). For example, where it is evident that the assessment criteria above could not be met even after further prevention and minimisation work (ie circumstances are such that the applicant cannot provide reassurance on operating without causing significant pollution from routine reasonably foreseeable emissions) then refusing the application for an environmental licence should be considered.

The assessment method provided above examines average releases (hourly) and therefore does not address the potential for very short term peak releases of odour. Such releases are likely to arise from abnormal operation and therefore, even if the assessment criteria are met, this would not guarantee that no offensive odour would be caused in any specific set of circumstances.

2.4 Controlling the release of odorous substances in environmental licences

Where an assessment indicates that the impact from releases would be acceptable any licence granted may still be required to contain appropriate conditions designed to ensure that the relevant objectives or aims and principles of Environmental Legislation are achieved.

Under PPC regulations
Regulation 9(3) requires emission limit values to be set for any substance which may be emitted in significant quantities (or supplemented or replaced by equivalent parameters or technical measures Regulation 9[9]).

The PPC regulations also provide (Regulation 9[11]) that there is implied in every permit, a condition (normally referred to as the "implied Best Available Technique [BAT] Condition") that installation or mobile plant operators will use BAT for preventing or reducing emissions from an installation or mobile plant. This implied condition does not apply in relation to any aspect of the operation of the installation or mobile plant which is regulated by a specific condition in the permit. The implied BAT condition is specifically not applied to landfills regulated under PPC.

For most activities regulated under PPC, including landfills, it may be appropriate that as a minimum, a generic condition is included as follows: "All emissions to air from the permitted installation shall be free from offensive odour, as perceived by an authorised person, outside the site boundary".

For PPC installations where the likelihood of the release of odorous substances is remote (ie odorous substances are not handled or generated) then the use of a generic odour condition is not required. The implied BAT condition should be sufficient.

For activities that could release odorous materials the generic condition should be used as a minimum with additional conditions included as necessary to control specific aspects of the operation by virtue of Regulation 9(9) to include supplemental or replacement conditions re equivalent parameters or technical measures.

Under the WML regime
The Waste Management Licensing (WML) regime does not have an equivalent implied condition in waste management licences requiring a minimum standard of operation, so if a specific release has not been addressed by a specific condition there can be no breach of a licence condition. However it should be noted that under the WML regime it is an offence to treat, keep or dispose of controlled waste in a manner likely to cause pollution of the environment or harm to human health.

For most waste activities regulated under WML it may be appropriate that as a minimum, a generic condition is included as follows: "Waste Operations shall be carried out so that offensive odours, in the opinion of an authorised SEPA officer, do not become detectable beyond the boundaries of the site"

Unlike the PPC Regulations, which specify types of conditions which must or may be included in a PPC Permit, the EPA90 and the Waste Management Licensing Regulations 1994 do not prescribe the types of conditions which a licence must contain. Section 35 (3) of EPA90 provides that a licence shall be granted on such terms and subject to such conditions as appear to [SEPA] to be appropriate. The conditions may relate to:

(a) the activities which the licence authorises;
(b) the precautions to be taken and work to be carried out in connection with or in consequence of those activities.

As a consequence, the approach to licensing activities which may release odorous material may differ depending on the regime. The latest version of the generic condition can be found incorporated into licence templates.

Conditions imposed in any licence or permit must always comply with ordinary principles of administrative law – that is they must be related to the underlying purpose of the legislation. SEPA's bank of conditions and template

licences provide conditions that are to be used in most cases, with examples of optional and additional conditions which can be used in specific circumstances.

Typical conditions aimed at controlling the potential release of odorous substances can address the following:

- a requirement to undertake routine odour self monitoring (the sniff test) and record and act upon findings;
- a requirement to have a formal and recorded odour management plan (see Appendix 4) for additional guidance);
- the inclusion of specific operational, maintenance and management requirements eg site infrastructure requirements, odour capture and containment etc (often needed to control potential fugitive or diffuse releases);
- the inclusion of specific emission limit values either limiting specific substances or mixtures of odours (See Section 2.5);
- the inclusion of a specific required odour destruction/abatement efficiency condition may be appropriate to ensure that key odour prevention and minimisation equipment is operating satisfactorily (in addition to the use of operational surrogates such as thermal oxidation temperature).

Examples of suitable conditions can be found in approved licence templates and/or the bank of conditions found in SEPA's quality system.

Animal rendering

There is a special case whereby the Secretary of State's Guidance Note SG8 for the A2 Rendering Sector (Statutory Guidance in England & Wales) provides for an odour condition that takes into account the particular circumstances surrounding this sector. The condition in this guidance allows for a due diligence test to be applied to the no offensive odour requirement and is drafted as follows:

"All emissions to air from the Permitted Installation shall be free from offensive odour, as perceived by an Authorised Person, outside the Site/Permitted Installation Boundary. It shall not be a breach of this Condition in a particular case if the Operator can show that all reasonable steps have been taken and due diligence exercised to prevent the release of offensive odour."

"Due diligence" means, in relation to condition [the odour condition], the application of BAT. This is inserted into interpretation of terms section of the licence. The Secretary of State's guidance also states that there should be "very few" escapes of offensive odour beyond the boundary of the site and that any escape should not exceed two hours on more than two occasions per year. In the event of this frequency being exceeded the regulator would be expected to undertake investigations into whether due diligence was being achieved.

2.5 Setting Emission Limit Value type conditions within licences

In some circumstances it will be appropriate to include specific quantitative emission limit values within an environmental licence to prevent and minimise emissions of pollutants and to ensure that pollution or nuisance through odours cannot occur.

In no circumstance should the indicative criteria specified in Table 2 be used as specific conditions of a licence. These criteria cannot be used directly as conditions, because the measurement of odour in the environment is very difficult at such dilute concentrations as may be present in ambient air samples outside the site boundary. The criteria used are based on hourly averages over a year. It is possible however to use the odour indicative criteria to set enforceable conditions within the licence and monitoring can then be undertaken to show compliance.

Case example

The assessment of an application identifies that a release concentration, of a mildly offensive odour in the exhaust gases of 20,000 OU_E/m^3, could result in the 3 OU_E/m^3 on the 98th percentile in the environment being exceeded at a housing estate located near the installation. The operator can operate abatement equipment to reduce the emission concentration to 6000 OU_E/m^3 which would ensure that the indicative criteria would not be exceeded. It would therefore be appropriate to impose this 6000 OU_E/m^3 as an emission limit value within the permit to ensure that BAT is used. In this case the ELV would be set as though the odour were a distinct substance. It is not appropriate, as discussed above, to impose any boundary limit such as 3 OU_E/m^3. The boundary limit is used to derive an emission limit value at the release point.

Alternatively, it may be appropriate to set monitoring standards for odour removal/abatement within equipment. This would be undertaken by sampling both the inlet and outlet gases and comparing them to derive a removal efficiency. This would give an indication of how well equipment is operating and may help identify problems. Different types of abatement equipment have different odour removal efficiencies. Some examples are provided in Table 3

Table 3: Abatement equipment odour removal efficiencies Note 1,2

Equipment type	Typical odour removal efficiency
Adsorption eg activated carbon systems	Depending on chemical species involved, efficiency can be >99%
Peat and heather type bio filters	Up to 95%
Soil type bio filters	>99%
Bio-scrubbers	>99%
Absorption (wet scrubbers)	>90% (2 stage water scrubber) >99% (chemical/catalyst type)
Thermal oxidation/Incineration	>>99%

Note 1: Each system has advantages and disadvantages depending on specific circumstances. More information on abatement systems is provided in Appendix 4
Note 2: Assumes well designed, maintained and operated equipment.

Part 3: Regulating operational facilities

3.1 Obligations

The grant of an environmental licence places obligations on an operator to comply with the conditions of the licence. SEPA also has obligations to ensure that the conditions are complied with.

The nature and frequency of inspections of licensed facilities should be determined by taking SEPA's environmental risk assessment manual[10] into account, which provides methods to assess the likely risks associated with any particular activity and recommended inspection frequencies.

3.2 Routine inspections and compliance assessment

For activities with the potential to release odorous substances, particular attention should be given during inspections to the techniques used to prevent or minimise the release of odorous substances, such as abatement equipment.

Appendix 4 provides useful information on the techniques that can be applied at these installations as well as providing notes on issues requiring particular attention during inspection.

Local management practices will be a general theme for inspection, because experience indicates that poor management practices in areas such as supervision, maintenance and training tend to lead to repeated and extended releases of odour. This aspect of controlling odorous substances should be one of the main focuses for inspection.

There are clear expectations that sites which may give rise to offensive odour are operated to a consistently high and robust standard such that the likelihood of a release is minimised, and where a release does occur it is effectively managed to mitigate any potential impact. The objective of any inspection programme should be to ensure that operators have practicable, robust and tested systems in place to achieve this. As discussed above more inherently odorous sites may have several odour related conditions inserted into their environmental licence. Compliance assessment against these conditions should be undertaken on a regular basis and even sites with a lower potential for odour release should be checked for compliance with any generic or simplified odour related conditions.

Guidance on assessing compliance can be found at:
www.sepa.org.uk/about_us/what_we_do/compliance_assesment.aspx

3.3 Investigations

Further guidance on incident and complaint responses including investigations into poor performance can be found in Part 4.

[10]This is can be found on Q-pulse. It will be amended following introduction of the Compliance Assessment Scheme.

Part 4: Incident and complaint response including investigation and enforcement

When responding to a complaint or when notified of an incident involving odour, the SEPA officer should take account of general guidance on responding to complaints and incidents[11].

As stated above in Part 1, the assessment that any odour is offensive is subjective and must be undertaken with care. It is therefore essential that a systematic approach is taken to assessing whether or not any detected odour is offensive. As a general rule, officers should carry out a field investigation (including a survey of the potentially affected area) and undertake the assessments specified in Appendix 3. This includes visiting any complainant as appropriate. Investigating officers should not go to the site suspected of giving rise to an odour until they have established the extent of any odour in the local area. This is to ensure that they have not become de-sensitised to the odour by being exposed to potentially high levels of the odour within the site, meaning that they can no longer detect levels of that odour which may be present in the wider environment.

As stated in Section 2, the offensiveness of an odour can be classified by using the 'FIDOL' factors. Taking these factors into account, the investigating officer should determine or estimate:

- the extent or possible extent of the pollution referring to the criteria below;
- the impact that pollution is having or could have on the environment, offence to senses, loss of amenity or prevention of legitimate use of the environment; (eg local circumstances should be noted such as time, events taking place, areas of high amenity, the weather, etc;
- the duration, or likely duration, of the event;
- the nature of the release, in particular its offensive properties (eg reference to Appendix 1 for hedonic tone, etc);
- if the release has occurred in the past; its frequency and its impact at that time.

The release of odorous substances may, if the odour is offensive or causes a nuisance, be a breach of an environmental licence (or legislation, if it concerns an exempt activity). It is therefore important that observations and assessments undertaken during an investigation are recorded.

Further, in most circumstances, especially where formal enforcement action is being considered, the presence of offensive odour will need to be corroborated by other witnesses, preferably another authorised SEPA officer.

Appendix 3 provides guidance and recording tools that can aid in assessing whether an odour, if present, is offensive. The response to odour incidents or investigations into the potential impact of the release of odorous substances provided in this guidance can be readily supplemented by the New Zealand guidance, which provides more detailed information on the techniques described here. It also provides other techniques that can be used in more complex or problematic situations.

The field investigation should identify the potential source of the odour. It is therefore important that the nature of the odour is described and that upwind and downwind assessments are undertaken to establish the source of the odour. Once the source and the offensiveness of the odour have been established, an officer should contact the relevant operator to seek details of the operation and advise them that their operations appear to be causing offence. If they are not doing so already then they should be advised to take appropriate action to stop/minimise the release. Section 4.2 provides some recommended actions that we can take.

SEPA officers investigating and/or monitoring any prolonged or repeated offensive odour events should seek to confirm if any health symptoms have been reported by members of the public. This can be achieved by contacting the relevant general health practitioners, local Health Boards and the health department of the local authorities in the community experiencing the odour. See SEPA's and HPS's *Dealing with assertions of human health risks or effects from environmental exposures: a systematic approach* for further advice.

[11]Stand By Guidance Notes EPR/001 found on Q pulse

In some circumstances, the source of the offensive odour may be obvious and the release stopped quickly. However, in many cases the precise cause of an offensive odour may be elusive or the potential solutions difficult to achieve in a short timescale. There is no single, absolute, technical fix that can be applied to all the different causes of offensive odours. There are many different means of preventing, controlling or reducing offensive odours.

In line with the principles of effective regulation, we should work with the operator in achieving a speedy resolution to the release of offensive odorous substances. It might be possible to agree a plan of action that starts with developing the options to minimise odour impacts and ends with the resolution of the problem. This plan of action should allow all those affected by the offensive odour to see that the choice of control measures proposed for a specific site has been arrived at in a way that is both technically justifiable and takes into account the balance of benefits and costs. All stakeholders should have confidence that the chosen option is appropriate to resolve the problem in the shortest possible time.

The actions we take, in line with the Enforcement Policy, should be proportionate to the impact being caused and the circumstances surrounding the event itself. While agreeing a plan to remedy any particular event is desirable, it should not preclude or avoid the use of the other regulatory powers and duties set in legislation. As a consequence and while assessing the odour, the SEPA officer should consider what impact is being caused. The result of this assessment should be recorded and the odour incident categorised as: Major Odour Incident, Significant Odour Incident, Minor Odour Incident or Unsubstantiated Odour Incident. These terms are described below. For each categorisation potential enforcement options are recommended. However, any final enforcement option decided upon should be made in light of all the facts available and in line with the Enforcement Policy.

4.1 Categorising an incident and suggested enforcement options

SEPA has an incident classification system for potential impacts on the air environment which can be found in Table 2 on Page 13 of the Compliance Assessment Manual:
http://www.sepa.org.uk/about_us/publications/better_regulation.aspx

These are classified these into four categories:

Table 4: SEPA's environmental classification scheme – Air

Category 1: major incident	Environmental impact	• Widespread and long term harm to the environment. • Substantial harm to human health.
	Amenity impact	• Substantial impairment of amenity for a prolonged period.
	Economic impact	• Extensive damage to and/or closure of commercial activities.
Category 2: significant incident	Environmental impact	• Long term but localised harm to the environment or widespread but short-term harm to the environment. • Minor or no harm to human health.
	Amenity impact	• Substantial impairment of amenity for a short period or lesser impairment of amenity for a prolonged period.
	Economic impact	• Significant damage to commercial activities.
Category 3: minor incident	Environmental impact	• Short-term and localised harm to the environment. • No harm to human health.
	Amenity impact	• Minor impairment of amenity for a short period or not at all.
	Economic impact	• Minor or no damage to commercial activities.
Category 4: other incidents (eg unsubstantiated complaints or incidents with no impact)	Environmental impact	• Inability to locate or substantiate reported event.
	Amenity impact	• No evidence of impairment of amenity.
	Economic impact	• No damage to commercial activities.

In relation to events involving the release of odorous substances the following additional guidance is provided for each category.

4.1.1 Major odour incidents (Category 1)

An incident involving the release or potential release of odorous substances which results or could result in one or more of the outcomes listed below should be considered to a be a major odour incident.

A major odour incident is one in which the release:

A) has a significant and distracting effect on humans.

> A "significant and distracting" effect on humans means odour that is persistent, widespread and at an intensity, offensiveness and extent that it leads to a change in behaviour of those exposed eg moving out of the affected area, experiencing nausea or sickness.

OR

B) could have a major adverse effect on amenity value or economic impact.

> An example of a major adverse effect would be an odour which prohibits the normal range of activities at an important recreation activity, event or public space.

OR

C) may result in danger to the public requiring action by the emergency services to advise the public on specific actions to be taken such as the closure of access roads, evacuation of property or a need to remain indoors.

The odorous release would normally be as result of an incident at an installation, resulting in a release of odour which is sufficiently strong, offensive and persistent that it interferes with activities or causes disruption at sensitive receptors.

Examples include private dwellings and public events, which are impacted for a prolonged period of time eg premature curtailment of activities. It is likely that a number of people are affected by the odour and that the impact extends beyond daytime disturbance eg weekends, evenings and public holidays.

If an incident occurs that causes or could cause a major odour incident as described above then it should be considered to be "serious pollution" for the purposes of Regulation 20 of the PPC Regulations or "serious pollution of the environment" or "serious harm to human health" or to be or become "seriously detrimental to the amenity of the locality" for the purposes of Section 38 of the Environmental Protection Act 1990. The boxes below provide further guidance on these requirements.

For PPC installations:

If SEPA is of the opinion that, in respect of a PPC regulated installation, the operation of the installation involves an imminent risk of serious pollution then we have a duty under Regulation 20 to suspend* the activities giving rise to that risk of causing serious pollution – ie suspend those activities causing or likely to result in a major odour incident (unless we are arranging for steps to be taken to remove the risk under Regulation 21[1]).

The method by which we achieve suspension in such circumstances is by serving a Suspension Notice under Regulation 20. In order to do so however, SEPA must specify in the notice, amongst other matters, the imminent risk, the steps to be taken to remove the risk and the period within which such steps must be taken (Regulation 20[4]).

It will hopefully be possible to specify such matters in the majority of relevant cases. It is possible, however, that there may be situations where we have difficulty in specifying such matters, and hence difficulty in serving a Suspension Notice. For example because the risk is no longer "imminent" (which may be the case if the plant has ceased operating prior to the notice being served) or because at the relevant point we are unable to pinpoint the steps to be taken to remove the risk or the period within which such steps should be taken.

For WML sites:

Under Section 38(6) of Part II of the Environmental Protection Act 1990 (in relation to Waste Management) SEPA has powers to suspend* activities if it appears to us that:

"(a) .....

(b) serious pollution of the environment or serious harm to human health has resulted from, or is about to be caused by, the activities to which the licence relates or the happening or threatened happening of an event affecting those activities; and

(c) that the continuation of those activities, or any of those activities in the circumstances will continue or, as the case may be, cause serious pollution of the environment or serious harm to human health"

We achieve suspension of activities under waste management regimes by serving a suspension notice under Section 38(6) of the EPA 90 as described above.

The terminology used is different from PPC and the "urgency" of suspension is defined by "about to be caused". There is no requirement to specify the steps to be taken to remove the risk of serious pollution or serious harm although SEPA may do so (Section 38[9]). Any notice would have to specify the extent of the suspension and the period at the end of which, or the event on the occurrence of which, the suspension will cease.

*In both the PPC and WML Regimes a suspension can be in full or in part. It should be noted that in the WML regime SEPA has discretion on whether or not to serve a Suspension Notice. However, under PPC Regulation SEPA must serve a Suspension Notice in certain circumstances.

Table 5 contains examples of situations that may constitute "imminent risk" or "about to be caused by".

Table 5: Examples of "imminent risk" or "about to be caused by" associated with the release of odorous substances (whether or not any licence condition may be breached).

The abatement system of a process dealing with odorous substances has failed and, while the process has stopped, the operator intends to imminently restart without the abatement system failure being rectified.
At a waste incinerator the plant has suffered major breakdown (involving a prolonged repair programme) but waste is still being received in the waste bunkers such that it may remain there for several days and begin to putrefy. Consideration of partial suspension to prevent further waste deliveries and requiring any waste already in the bunkers to be removed may be appropriate if the operator has not already taken those steps.
A landfill site is being operated in a way that waste is being tipped into liquid (leachate/water) and the tipping operation cannot be undertaken so as to ensure that any gases evolved can be contained or abated.
The structure of a process building has been damaged following high winds which have removed roof panels etc in such a manner that fugitive process emissions cannot be prevented and the operator has indicated that they are going to continue or imminently restart operations.
An operator proposes to undertake abnormal operations, such as disturbing the waste mass in a landfill where there is high risk that a release could result in a significant or major odour incident.
It is found that a plant is being operated with a substantially reduced number of site staff such that any process excursion may quickly grow out of control and lead to a major or significant odour incident.
There is a history of odorous releases in the past and the activity is being operated in a similar manner such that there is likely to be a repeat major or significant odour incident. For example the operator has not intervened in the process or planned contingencies in the event of a repeat of a previous failure.

Serving a suspension notice will not be required if the operator has already taken appropriate steps to remove the risk of a release that could lead to serious pollution, although this does not preclude us taking other enforcement action as appropriate. In all cases consideration as to the likely impact such events could have on the environment and human health must be considered.

The circumstances surrounding the issue of a suspension notice will often be unique and, given the severity of such an action, officers should ensure that information obtained during an incident investigation/response is carefully recorded and that the issue of the suspension/prohibition is approved in accordance with SEPA's policies and procedures.

In the event of a major odour incident consideration should also be given to reporting the matter to the Procurator Fiscal.

4.1.2 Significant odour incidents (Category 2)

An incident involving the release or potential release of odorous substances which results or could result in one or more of the criteria listed below should be considered to a be a significant odour incident if:

A) it would result in an abnormal and prolonged disturbance due to odour. This would typically lead to disruption rather than to evacuation of dwellings etc.

Or

B) the release could result in a reduction in amenity value. This would typically mean that the odour is sufficiently offensive and persistent that it prevents or significantly restricts the local population's use of an amenity or recreation area such as a park for a period of one or more days during the week, but typically does not extend to weekends and public holidays.

Any occurrence that causes or could cause a significant odour incident as described here should be assessed as to whether or not it should be taken to be "serious pollution" for the purposes of Regulation 20 of the PPC Regulations or "serious pollution of the environment" or "serious harm to human health" or to be or become "seriously detrimental" to the amenity of the locality for the purposes of Section 38 (6) of the Environmental Protection Act 1990. Following a significant odour incident, formal action seeking prevention of future events is recommended, including serving appropriate enforcement notices

Consideration should also be given to reporting the event to the Procurator Fiscal, especially if this is a repeat event.

4.1.3 Minor odour incidents (Category 3)

An incident involving the release or potential release of odorous substances which results or could result in one or more of the criteria listed below should be considered to be a minor odour incident and be taken as likely to be minor pollution if:

A) it would involve a minimal effect on humans eg a change in odour emissions, which is short-term and/or intermittent and affects a small localised population during the daytime.

Or

B) it could result in a minimal effect on amenity value which, in relation to odour, means a localised, minor or transitory effect on local amenities that aren't necessarily considered to be sensitive receptors, such as sports pitches etc. Normally a small proportion of the amenity area, as opposed to the whole amenity area, would be affected and people would still be using the area, despite complaints being received.

PPC Sector Guidance note SG8 on animal rendering processes provides that Best Available Techniques (BAT) may be seen to be undertaken in relation to odour if the operator is taking all reasonable steps and exercising due diligence. In particular, the guidance indicates that as a threshold there should be no more than two incidents per year and that these incidents last no more than two hours. An incident lasting no more than two hours may be considered to be a minor odour incident subject to the impact criteria identified above.

However, where there are repeat incidents these should be investigated with a view to ensuring that all reasonable steps and appropriate standards are being used to prevent and/or minimise these repeat incidents. The results of any such investigation should be followed up in accordance with SEPA's enforcement policy.

Extract from BAT Box 31 of the Secretary of State's Guidance Note on Animal Rendering (SG8 2004)

Local authorities will need to investigate incidents where offensive odour escapes across the site boundary to establish whether there has been a breach of any odour boundary condition. The Secretary of State would expect that if a rendering process is properly managed, with the operator taking all reasonable steps and exercising all due diligence, there should be very few escapes of offensive odour beyond the site boundary. Certainly he [the Secretary of State] would expect local authorities to investigate very carefully whether an operator was taking all reasonable steps and exercising all due diligence if there were more than two such occurrences in any 12-month period. In the event of any occurrence, the operator should immediately take remedial action to prevent any further escape of offensive odour and he would expect this to be effective within at most two hours. Again, the Secretary of State would expect local authorities to investigate with particular care the management of a rendering activity where remedial action had not been effective within 2 hours.

4.1.4 Other Incidents such as unsubstantiated complaints etc. (Category 4)

Many complaints from members of the public are unsubstantiated by authorised officers. This may be due to the transient nature of odorous releases which can have an impact over a very short period of time. These complaints should not be ignored and should be responded to in accordance with SEPA's policies in relation to complaint response. In all cases, the complaint should be logged in our environmental events system, even if unsubstantiated, so that a history of complaints can be established. Such information may be useful in tracking potential releases and allowing us to develop an appropriate intervention plan, if required.

Similarly, where a complaint is substantiated but there may be more than one probable source, this too should be logged in order to build up information on the possible source(s) and thus inform consequential actions.

Where an operator reports a release (in accordance with their licence) as an incident this should be logged and depending on the nature of the event, investigated. This may simply be by awaiting the operator's investigation report. The incident should be recorded whether or not the release has provoked complaint or identification of offensive odour beyond the site boundary by an authorised officer. Information of this nature can be used to detect patterns of operation and perhaps aid in the prediction of more significant incidents (and thus allow for intervention to prevent them). This is similar to the health and safety 'near miss' recording schemes for industrial accidents.

4.2 Activities operating without an environmental licence

In the case of unlicensed activities (ie those which require a licence from SEPA but have none) which may result in, or are resulting in, pollution from the release of odorous substances resulting in offensive odour the following must be considered:

- the activity is operating without a relevant environmental licence[12] and should be advised to stop operating or risk compounding the severity of any potential offence by continuing to operate[13];
- the operator should be advised to apply for the relevant environmental licence as soon as possible;
- where the operator chooses to continue operating without making a relevant application and that operation gives rise to pollution, then consideration should be given to whether an interdict (and interim interdict) can be sought to prevent continued operation until the environmental licence application can be determined and/or the potential risk of the release of odorous substances has been removed or has been significantly reduced;
- in all cases above, and in accordance with the Enforcement Policy, consideration should be given to referring the matter to the Procurator Fiscal.

4.3 Other considerations

Use of PPC Regulation 21 or EPA 90 Section 59(7) Powers

Consideration of the use of SEPA's powers to take direct action to remove the risk of serious pollution should not be taken lightly. Senior management permission following legal advice must be obtained before using these powers.

Use of the court to seek remedy

EPA90 and the PPC Regulations provide for situations where we believe that the service of a formal notice would provide ineffectual remedy (EPA 90 Sections 38[13] or 42[6A] and PPC Regulation 31).

Consideration may also be given to seeking an (interim) interdict from the courts if an operator fails to suspend activities following the service of a suspension notice or in the case of an unlicensed activity (which should be licensed) where we have no powers to issue a formal notice. Senior management permission following legal advice must be obtained before seeking any court remedy such as interdict.

[12]In this context environmental licence includes the circumstances where an exemption to licensing would be permitted, e.g. a registered Waste Management Licence exemption
[13]SEPA can only stop an activity via a formal notice if it is already formally regulated by SEPA or if not via seeking a court order (an interdict) for the operator to cease activities.

Part 5: Working with communities

Statutory guidance to SEPA made under Section 31 of the Environment Act 1995 directs us to use our statutory powers to support the aims of environmental justice, in particular to prevent environmental burdens falling disproportionately on particular (vulnerable) communities or sectors of society. We are directed to encourage and inform public participation in decisions affecting their environment and sustainable development and to encourage engagement between industry (and other institutions) and their local communities on environmental and sustainable development issues. The guidance also directs us to assess and understand the impacts of emissions on health, and take action to minimise such impacts within the framework established by legislation. Such action should encompass issues that have a significant effect on well-being such as odour and noise, where these are subject to regulation.

For the purposes of Section 6 of the Human Rights Act 1998 we, as a public body, must act in a way which is compatible with the Convention on Human Rights (the European Convention on Human Rights [ECHR] is incorporated into Scots law through the Human Rights Act 1998). We must therefore find a fair balance between the protection of individual rights and the interests of the environment and the general public when interfering with a convention right.

Clear and effective communication and the provision of useful information are essential when working with a local community which may be or is being affected by offensive odours.

Operators should be encouraged to have a proactive system of informing us and the local community, especially if they are planning to undertake any non routine activity which could give rise to odour, for example cleaning of equipment. This will allow us to engage with an operator about the best way in which to undertake the work, and it also means we are informed in advance should a complaint be made during that work. Similarly, operators should ensure that they report incidents or possible incidents relating to the release of odorous substances promptly to us so that we can provide advice and support.

The length of time from identification of a problem to its resolution can be a common reason for community concerns regarding odour impact, even though we may have taken appropriate action to prevent further incidents. Local communities may not be aware of these actions and the time period an operator has been required or allowed to make improvements, repairs etc. This is particularly true in situations where an upgrade has been agreed (informal as well as formal) and complaints are still received during the interim upgrade period. Therefore it is important to put an adequate process of communication in place with local communities.

SEPA aims to be a fair and reasonable regulator and the Enforcement Policy does allow for informal enforcement via meetings and site visits etc. as well as more formal actions such as enforcement notices or variations to environmental licences. Informal agreements can be as effective as a proportionate regulatory tool, but they can be perceived by the public to be an easy option for the operator. Where an operator has volunteered to undertake certain work they must be made to adhere to any agreement. If not, more formal action should follow. These agreements should be in writing with the key expectations detailed, such as performance expectations and dates for compliance.

There is a clear need for liaison and communication with affected communities to keep them informed of what actions have been taken or will be taken, including details of any volunteered actions. Liaison and communication could involve writing to affected people, face to face meetings, attending community group meetings, contacting and discussing issues with local and/or national elected representatives, etc. This will allow affected people to participate as appropriate in the process while it is undertaken. Advice on effective liaison and communication can be obtained from the Communications Department. Table 6 summarises benefits that can be realised by having effective community liaison.

SEPA's Vision for Regulation provides further guidance.

Table 6: Potential benefits of effective community liaison

Benefits for the community: • receive more information and hopefully reassurance that actions are being taken; • receive information on the potential impacts from the release of the odour eg health impact information; • the ability for groups to discuss problems with the operator and regulator directly; • participate in decisions that affect them.
Benefits for the regulator: • more focussed complaints/reports from the community; • a direct route to provide information to the community affected; • the ability to take a more active role in dealing with odour problems, which hopefully leads to a reduced number of odour incidents.
Benefits for the operator: • quick and accurate feedback when odour is emitted from the plant; • time to make changes; • more interest and involvement from the employees who may be part of the affected community; • goodwill from the community because the operator is seen to take the odour problem seriously; • a reduced number of complaints from upset people.

Glossary of terms and acronyms

Abatement system/ equipment	Means of preventing or reducing the amount of undesirable materials being released from an installation.
ADMS & AERMOD	Air dispersion modelling software tools.
BAT	Best Available Techniques as defined in the Pollution Prevention and Control (Scotland) Regulations 2000 (as amended).
BAT Reference Document (BREF)	Technical documents developed primarily to assist in the determination of best available techniques (BAT) under Directive 96/61/EC concerning integrated pollution prevention and control (IPPC). Documents are produced for each of the activities described. http://eippcb.jrc.ec.europa.eu/reference/
British Standards (BS)	British (national) published document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline or definition.
Beaufort scale	An empirical measure for describing wind velocity designed mainly on observed sea conditions, it now incorporates land conditions as well.
CEN	Comite Europeen de Normarilisation (CEN) Standard. A European Standard.
Department for Environment, Food and Rural Affairs (DEFRA)	The UK Government Department overseeing the Environment, Food and Rural Affairs in England and Wales and primary lead on environmental policy at a European level for the UK. www.defra.gov.uk
Dynamic olfactometry	Method of odour concentration measurement (a standardised method is detailed in BS EN13725: 2003 *Air Quality, Determination of Odour Concentration by Dynamic Olfactometry*).
D1 - Technical Guidance Note (Dispersion) (D1)	Technical guidance providing guidelines on discharge stack heights for polluting emissions published by Her Majesty's Inspectorate of Pollution.
ELV	Emission Limit Value.
Enforcement notice	Formal notice issued by SEPA to ensure compliance with a Permit / Licence. The notice confirms what constitutes the contravention, what steps need to be taken to rectify the contravention and by when the steps should be completed.
Enforcement policy	Our published approach to handling non-compliance with any environmental legislation which SEPA is responsible for.
Environment Agency (EA)	The leading public body/regulator for protecting and improving the environment in England and Wales. www.environment-agency.gov.uk
Northern Ireland Environment Agency	The leading public body/regulator for protecting and improving the environment and built heritage in Northern Ireland. www.ni-environment.gov.uk

Environmental Impact Assessment (EIA)	EIA is a tool used to predict environmental impacts at an early stage in the planning and design of a new development, as well as to find ways of reducing adverse impacts and shape projects to suit the local environment. In terms of planning it refers to the whole process by which environmental information is collected, publicised and taken into account in reaching a decision on a relevant planning application.
EPA90	Environmental Protection Act 1990.
European Odour Unit, $OU_E.m^{-3}$	The amount of odorous species that, when evaporated into 1 cubic metre of neutral gas at standardised conditions, elicits a response (detection threshold) from a panel equivalent to that elicited by one European Reference Odour Mass (EROM) under the same conditions. The reference substance used is n-butanol. One EROM of n-butanol is 123 µg.
European Reference Odour Mass (EROM)	See European Odour Unit.
European Standards (EN)	European published document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline, or definition.
FIDOL	Methodology for assessing the offensiveness of odour through describing the following characteristics; Frequency, Intensity, Duration, Odour unpleasantness and Location.
GC-MS	Gas chromatography-mass spectrometry (analytical method).
Hedonic tone	A subjective ranking system where a panel of human assessors is exposed to a given sample and asked to rank it on a scale, with pleasant odours being assigned a positive value and unpleasant odours a negative value.
Human Rights Act 1998	Act of Parliament designed to give further effect in UK law to the rights and freedoms contained in the European Convention on Human Rights.
Integrated Pollution Prevention & Control (IPPC	IPPC is the primary EU legislative mechanism used to regulate emissions from larger industries.
Logarithmic relationship	Logarithms are a mathematical tool usefully employed to handle numbers of very different magnitudes. This is most obviously seen when plotting values: using base 10, the scale points are equally spaced eg log101, log1010, log10100 would appear as 0, 1, 2. For example the pH and Richter scales are also logarithmic in nature.
Oedema (pulmonary)	This is a medical condition characterised by swelling and/or fluid accumulation in the lungs, leading to impaired gas exchange and respiratory failure in extreme cases. It has many causes, including heart failure and inhalation of toxic gases
Odour characterisation	Odour is often characterised using a list of standard descriptors: generally, a panel of assessors are exposed to an odour and asked to describe it in terms of a given list of adjectives (eg floral, fishy, earthy etc) and assign it an intensity on between 0-5.
Odour threshold	The amount of dilution required to bring a specific species (or group of species) in a given air sample to its detectable threshold.

Olfactometry	The scientific measurement of odour concentration utilising a system of sampling and a regulated methodology to European standard (BS EN 13725).
Pollution	For the purposes of Pollution Prevention Control Regulations, pollution is defined as "emissions as a result of human activity which may be harmful to human health or the quality of the environment, cause offence to any human senses, result in damage to material property, or impair or interfere with amenities and other legitimate use of the environment" For the purposes of EPA 1990 "Pollution of the environment" includes pollution of the environment, due to the release or escape (into any medium) from land where controlled waste is treated, kept or deposited of substances or articles constituting or resulting from the waste and capable (by reason of the quantity or concentration involved) of causing harm to man or any other living organisms supported by the environment. "Harm" for this purpose means harm to the health of living organisms or other interference with ecological systems of which they form part and in the case of man includes offence to any of his senses or harm to his property. [Section 29 EPA1990]
PPC regulations	Pollution Prevention and Control (Scotland) Regulations 2000 (as amended).
Procurator Fiscal	The sole public prosecuting authority in Scotland.
Statutory nuisance	These are the provisions contained within Section 79(1)(d) Part III of the Environmental Protection Act 1990, relating to (amongst other things) an odour arising from an industrial or commercial premises which is prejudicial to health or a nuisance.
Suspension notice	A formal notice issued by SEPA to suspend all or part of the activities carried out under a permit/licence. The notice confirms what constitutes the imminent risk/reason for suspension, what is suspended, what steps need to be taken to lift the suspension and how the suspension will be lifted.
Tedlar	This is a polyvinyl fluoride polymer developed by DuPont. It is highly inert towards a wide range of chemical species hence finds particular application in field science where it is employed in bags to avoid sample degradation prior to analysis.
Town and Country Planning (Scotland) Act 1997	Defines the scope of town and country planning and sets out the general legislative framework for the preparation of structure and local plans and the administration of development control.
WML regulations	Waste Management Licensing Regulations 1994 (as amended).
WWTP	Waste Water Treatment Plant.

References and other sources of information

This guidance complements and can be used with the information provided in a number of guidance documents from around the world recognising best practice in the field of odour regulation. These include:

PPC Horizontal Guidance Note for Odour Parts 1 and 2 – (H4) in draft (2002)
and associated Environment Agency science reports such as SC030170/SR3 Review of dispersion modelling for odour predictions and SC030170/SR2 Review of odour character and thresholds. The H4 guidance aims to bring together a number of aspects relating to the permitting and regulation of odour-generating activities and shows how these aspects can be applied within the BAT framework of IPPC.

Note: at the time of publication the Environment Agency were in the process of finalising the H4 guidance. Any references in this guidance document are to the original 2002 H4 drafts.

Statutory Code of Practice on Odour Control of Odour from Waste Water Treatment Plants (2006)
The Water Services etc Act (Scotland) 2005 allowed Scottish Ministers to make a new order containing a Code of Practice for the purposes of assessing, controlling and minimising sewerage nuisance. The above Code of Practice relates to odour releases from Waste Water Treatment Plants (WWTPs) which would be handled by the local authority under statutory nuisance powers. This Code of Practice does not have statutory status in relation to the small number of WWTP activities regulated by SEPA under the WML and PPC regimes; however it does provide useful information and assessment tools. The Code of Practice can be found on the Scottish Government website at: www.scotland.gov.uk/Publications/2006/04/20140331/0

Good Practice Guide for Assessing and Managing Odour in New Zealand. New Zealand Ministry of the Environment, 2003. This publication provides guidance on determining if an odour is causing an offensive effect, and how to reduce the potential for odours to cause problems. The New Zealand guidance is available online at: www.mfe.govt.nz/publications/air/odour-guidelines-jun03/html/index.html

Composting Odour Guidance
During the preparation of this guidance DEFRA published a new guidance document for composting industries which will be of use in dealing with this type of activity and also provides further generic information on odour issues that can be used in other industrial sectors and this complements this guidance: www.defra.gov.uk/environment/noise/research/pdf/composting-odour-guidance.pdf

There are also several other documents which are not specifically on the subject of odour but do include useful sections on odour in relation to specific industrial sectors etc:

- **BAT Reference (BREFs) documents** published by the European Commission: http://eippcb.jrc.ec.europa.eu/reference

- **PPC Technical Guidance Note Series** (PPC Part A sector specific), issued by the Environment Agency, SEPA and Northern Ireland Environment Agency: www.sepa.org.uk/air/pollution_prevention__control/uk_technical_guidance.aspx

- **Sector guidance notes** (for England and Wales Part A2 activities[14]), issued by Defra: www.defra.gov.uk/environment/ppc/localauth/pubs/guidance/notes/sgnotes/index.htm

- **Process Guidance Notes** (PPC Part B sector specific): www.defra.gov.uk/environment/ppc/localauth/pubs/guidance/notes/pgnotes/index.htm

- **Standard Farming Installation Rules** (for PPC Intensive Agriculture installations in Scotland), issued by SEPA: www.sepa.org.uk/air/pollution_prevention__control/intensive_agriculture.aspx

- **Health Impacts of Odour (AEA Reports on behalf of SEPA)**
  Task 1: *Assessment of Health Effects of Odorous Substances.* AEA/ED43076 Feb 2008
  Task 2: P*ollution Control – Minimising the Health Effect of Odour.* AEA/ED43076 Feb 2008

[14]These activities are regulated in Scotland by SEPA as Part A activities.

Appendix 1: describing and characterising odour

Table A1.1: Common descriptions

Flora	Fruity	Vegetable	Earthy	Offensive	Fishy	Chemical	Medicinal
Almond	Apple	Celery	Ashes	Blood	Amine	Burnt plastic	Alcohol
Cinnamon	Cherry	Corn	Burnt wood	Burnt	Dead fish	Car exhaust	Ammonia
Coconut	Citrus -	Cucumber	Chalk	Burnt rubber	Perming solution	Cleaning fluid	Anaesthetic
Eucalyptus	Cloves	Dill	Coffee	Decay		Coal	Camphor
Fragrant	Grapes	Garlic	Grain silage	Faecal		Creosote	Chlorine
Herbal	Lemon	Green pepper	Grassy	Refuse		Diesel	Disinfectant
Lavender	Maple	Nutty	Mould	Landfill leachate		Petrol	Menthol
Liquorice	Melon	Potato	Mouse-like	Manure		Grease	Soap
Marigolds	Minty	Tomato	Mushroom	Mercaptan		Foundry	Vinegar
Perfumy	Orange	Onion	Musky	Putrid		Kerosene	
Roses	Strawberry		Musty	Rancid		Molasses	
Spicy	Sweet		Peat	Raw meat		Mothballs	
Vanilla			Pine	Rotten eggs		Oil	
			Smoky	Septic		Paint	
			Stale	Sewer		Petroleum	
			Swampy	Sour		Plastic	
			Woody	Spoiled milk		Resins	
			Yeast	Urine		Rubber	
				Vomit		Solvent	
						Styrene	
						Sulphur	
						Tar/asphalt	
						Turps	
						Varnish	
						Vinegar	
						Vinyl	

Table A1.2: Odour descriptors for commonly encountered compounds (by compound)

Substance	Odour	Substance	Odour
Acetaldehyde	Apple, stimulant	Dimethyl sulphide	Rotten vegetable
Acetic acid	sour vinegar	Diphenylamine	Floral
Acetone	chemical/sweetish/solvent	Diphenyl sulphide	Burnt rubber
Acetonitrile	Ethereal	Ethanol	Pleasant, sweet
Acrylaldehyde	Burning fat	Ethyl acetate	Fragrant
Acrolein	Burnt sweet, pungent	Ethyl acrylate	Hot plastic, earthy
Acrylonitrile	Onion, garlic, pungent	Ethylbenzene	Aromatic
Aldehydes C9	Floral, waxy	Ethyl mercaptan	Garlic/onion, sewer, decayed cabbage, earthy
Aldehydes C10	Orange peel	Formaldehyde	Disinfectant, hay/straw-like, pungent
Allyl alcohol	Pungent, mustard like	Furfuryl alcohol	Ethereal
Allyl chloride	Garlic onion pungent	n-Hexane	Solvent
Amines	Fishy, pungent	Hydrogen sulphide	Rotten eggs
Ammonia	Sharp, pungent odour	Indole	Excreta
Aniline	Pungent	Iodoform	Antiseptic
Benzene	Solvent	Methano	Medicinal, sweet
Benzaldehyde	Bitter almonds	Methyl ethyl ketone	Sweet
Benzyl acetate	Floral (jasmine), fruity	Methyl isobutyl ketone	Sweet
Benzyl chloride	Solvent	Methyl mercaptan	Skunk, sewer, rotten cabbage
Bromine	Bleach, pungent	Methyl methacrylate	Pungent, sulphide like
Sec-Butyl acetate	Fruity	Methyl sulphide	Decayed vegetables
Butyric acid	Sweat, body odour	Naphthalene	Moth balls
Camphor	Medicinal	Nitrobenzene	Bitter almonds
Caprylic acid	Animal like	Phenol	Sweet, tarry odour, carbolic acid
Carbon disulphide	Rotten vegetable	Pinenes	Resinous, woody, pine-like
Chlorine	Irritating, bleach, pungent	Propyl mercaptan	Skunk
Chlorobenzene	Moth balls	Putrescine	Decaying flesh
2-Chloroethanol	Faint, ethereal	Pyridine	Nauseating, burnt
Chloroform	Sweet	Skatole	Excreta, faecal odour
Chlorophenol	Medicinal	Styrene	Penetrating, rubbery, plastic
p-Cresol	Tar-like, pungent	Sulphur dioxide	Pungent, irritating odour
Cyclohexane	Sweetish when pure, pungent when contaminated	Thiocresol	Rancid, skunklike odour
Cyclohexanol	Camphor, methanol	Toluene	Floral, pungent, moth balls
Cyclohexanone	Acetone-like	Trichloroethylene	Solventy
Diamines	Rotten flesh	Triethylamine	Fishy, pungent
1,1-Dichloroethane	Ether-like	Valeric acid	Sweat, body odour, cheese
1,2-Dichloroethylene	Chloroform-like	Vinyl chloride	Faintly sweet
Diethyl ether	Pungent	Xylene	Aromatic, sweet
Dimethylacetamide	Amine, burnt, oily		

Source: H4.Table A10.1:

References The Royal Society of Chemistry, Chemical Safety Data Sheets Volumes 1 and 5.
Knowlton J and Pearce S, Handbook of Cosmetic Science and Technology.
Leonardos G, Kendall D and Bernard N, Odour threshold determinations of 53 odorant chemicals JAPCA Volume 19, No 2, 1969.
Turk, Atmospheric gases and vapours Annals New York Academy of Sciences.

Table A1.3: Odour descriptors for commonly encountered compounds (by odour descriptor)

Odour	Substance	Odour	Substance
Acetone-like	Cyclohexanone	Medicinal	Camphor
Animal like	Caprylic acid	Medicinal	Chlorophenol
Antiseptic	Iodoform	Medicinal, sweet	Methanol
Apple, stimulant	Acetaldehyde	Moth balls	Chlorobenzene
Aromatic	Ethylbenzene	Moth balls	Naphthalene
Aromatic, sweet	Xylene	Nauseating, burnt	Pyridine
Bitter almonds	Benzaldehyde	Onion, garlic, pungent	Acrylonitrile
Bitter almonds	Nitrobenzene	Orange peel	Aldehydes C10
Bleach, pungent	Bromine	Penetrating, rubbery, plastic	Styrene
Burning fat	Acrylaldehyde	Pleasant, sweet	Ethanol
Burnt rubber	Diphenyl sulphide	Pungent	Aniline
Burnt sweet, pungent	Acrolein	Pungent	Diethyl ether
Camphor, methanol	Cyclohexanol	Pungent, irritating odour	Sulphur dioxide
chemical/sweetish/solvent	Acetone	Pungent, mustard like	Allyl alcohol
Chloroform-like	1,2-Dichloroethylene	Pungent, sulphide like	Methyl methacrylate
Decayed vegetables	Methyl sulphide	Rancid, skunklike odour	Thiocresol
Decaying flesh	Putrescine	Resinous, woody, pine-like	Pinenes
Disinfectant, hay/straw-like, pungent	Formaldehyde	Rotten eggs	Hydrogen sulphide
Ethereal	Acetonitrile	Rotten flesh	Diamines
Ethereal	Furfuryl alcohol	Rotten vegetable	Carbon disulphide
Ether-like	1,1-Dichloroethane	Rotten vegetable	Dimethyl sulphide
Excreta	Indole	Sharp, pungent odour	Ammonia
Excreta, faecal odour	Skatole	Skunk	Propyl mercaptan
Faint, ethereal	2-Chloroethanol	Skunk, sewer, rotten cabbage	Methyl mercaptan
Faintly sweet	Vinyl chloride	Solvent	Benzene
Fishy, pungent	Amines	Solvent	Benzyl chloride
Fishy, pungent	Triethylamine	Solvent	n-Hexane
Floral	Diphenylamine	Solventy	Trichloroethylene
Floral (jasmine), fruity	Benzyl acetate	sour vinegar	Acetic acid
Floral, pungent, moth balls	Toluene	Sweat, body odour	Butyric acid
Floral, waxy	Aldehydes C9	Sweat, body odour, cheese	Valeric acid
Fragrant	Ethyl acetate	Sweet	Chloroform
Fruity	Sec-Butyl acetate	Sweet	Methyl ethyl ketone
Garlic onion pungent	Allyl chloride	Sweet	Methyl isobutyl ketone
Garlic/onion, sewer, decayed cabbage, earthy	Ethyl mercaptan	Sweet, tarry odour, carbolic acid	Phenol
Hot plastic, earthy	Ethyl acrylate	Sweetish when pure, pungent when contaminated	Cyclohexane
Irritating, bleach, pungent	Chlorine	Tar-like, pungent	p-Cresol

Table A1.4: Summary of the observed effects of typical odorants taken from *Health Impacts of Odour*. ED43076 – Draft A AEA Energy & Environment

Acrolein

Effects	ppm	mg m^{-3}
Odour detection threshold	0.05-37.5	0.02-16.3
Odour annoyance threshold	0.54	1.25
Threshold for irritation of eyes and nose	0.06-0.15	0.13-0.34
Threshold for longer term respiratory damage (animal data)	0.4	0.9
Severe irritation (5 minutes exposure)	2.2	5
Irritation, barely tolerable (5 minutes)	1.2	2.8
Immediate risk of irreversible effects	2	4.6

Alkylamines (ethylamine and triethylamine)

Effects	ppm	mg m^{-3}
Odour detection threshold Ethylamine Triethylamine	 97 48	 180 200
Odour annoyance threshold Ethylamine Triethylamine	 0.26-214 0.08-0.27	 0.48-396 0.36-1.12
Visual disturbance (triethylamine – 4 hours)	1.6	6.5
Severe irritation of the eyes, irritation of the respiratory symptoms (triethylamine)	3-4	

Ammonia

Effects	ppm	mg m^{-3}
Odour detection threshold	0.04-57	0.0266-39.6
Odour annoyance threshold	103	72
Immediate irritation to the throat	408	284
Immediate irritation to the eye	698	486
Coughing	1720	1198
Short exposure rapidly fatal	5000-10000	3483-6965

Bacterial and fungal spores

Effects	Cfu m^{-3}	Comments
Odour threshold	Not identifiable	VOCs present depend on species mix and their metabolic activity.
Nausea, fatigue, respiratory symptoms	$>10^3$ $cfum^{-3}$	Effects dependent on species mix in microbial aerosol.

Formaldehyde

Effects	ppm	mg m^{-3}
Odour detection threshold	0.02-0.5	0.03-0.6
Odour annoyance threshold	0.08-2.53	0.1-3.1
Eye irritation	0.05	0.06
Throat irritation	0.08-2.50	0.1-3
Lower airway and pulmonary irritant effects expected	>5	>6
Difficulty in breathing	20	25
Serious damage to lower respiratory tract after 5-10 minutes exposure.	50-100	60-120

Hydrogen cyanide

Effects	ppm	mg m^{-3}
Odour threshold	0.6-4.5	0.6-5
Difficulty breathing, rapid heart rate, paralysis, palpitations, unconsciousness, respiratory arrest, death	50	55
Endangering to life (30-60 minute exposure)	150	166
Lethal (30-60 minutes)	100-200	111-221
Death in minutes	300	332

Hydrogen halides (hydrogen fluoride, hydrogen chloride)

Effects	ppm	mg m^{-3}
No effect level for respiratory effects (hydrogen chloride).	0.2-10	0.30-14.9
Odour detection threshold (hydrogen chloride) Odour detection threshold (hydrogen fluoride)	1-5 0.04-0.16	1.5-7.5 0.03-0.13
Upper respiratory tract inflammation (hydrogen fluoride).	0.5	0.4
Immediately irritating to nose and throat (hydrogen chloride).	5	7.5
Barely tolerable (hydrogen chloride).	50-100	75-149
Immediately dangerous (hydrogen chloride).	1000-2000	1490-2980
Lethal (30 minute exposure) (hydrogen chloride).	1300	1941
Lethal (5 minute exposure) (hydrogen chloride).	3000	4479
Lethal following 30-60 minutes exposure (hydrogen fluoride).	50	41

Hydrogen sulphide

Effects	ppm	mg m^{-3}
Odour threshold	0.02-0.025	0.06-0.08
Distinct odour	0.3	0.9
Offensive, moderately intense odour	3-5	9-16
Obvious, unpleasant odour; sore eyes	10	31
Strong, intense odour but not intolerable	20-30	62-93
Conjunctival irritation first noticeable	50	156
Mild irritation to respiratory tract and eyes after 1 hour	50-100	156-311
Loss of smell in 3-15 minutes, may sting eyes and throat	100	311
Prolonged exposure may cause pulmonary oedema	250	779
Rapid collapse, respiratory paralysis, imminent coma, followed by death within minutes	1000	3114

Ketones (methyl isobutyl ketone and acetone)

Effects	ppm	mg m^{-3}
Odour threshold (MIK) Odour threshold (acetone)	0.1-47 20-680	0.41-192.7 47.4-1613
Irritation of eyes, nose and throat; headache, nausea, vertigo (MIK)	2.4-100	10-410
Irritation of the eyes, nose and throat (acetone)	100-300	720
Discomfort (MIK)	200	820
Serious effects leading to possible coma and death on exposure >30 minutes (MIK)	>500	>2050
Immediate risk of death (MIK) Immediate risk of death (acetone)	2000 5000	8200 11950

Methanethiol

Effects	ppm	mg m^{-3}
Odour detection threshold	<0.04	<0.08
Respiratory irritation	>0.5	>1
Headaches and nausea after several hours exposure	4	8
Collapse, breathlessness, convulsions, death	150	295

Other sulphides (carbon disulphide, dimethyl sulphide and dimethyl disulphide)

Effects (Carbon disulphide unless otherwise stated)	ppm	mg m^{-3}
Odour detection threshold Carbon disulphide Dimethyl sulphide Dimethyl disulphide	 0.02-0.2 0.001-0.02 0.00003-0.09	 0.05-0.5 0.0025-0.0508 0.0001-0.34665
Effects on peripheral nervous system	5	15
Effects on motor function following long term exposure (years)	10	15-30
Minor symptoms in 30 minutes	300	933
Distinct symptoms in 30 minutes	400	1244
Immediate severe headache	760	2364
Severe poisoning in 30 minutes	1150	3577
Loss of consciousness in 30 minutes	3000	9330
Death in 30-60 minutes	5000	15550

O - Pinene

Effects	ppm	mg m^{-3}
Odour detection threshold.	0.7	3.9
No quantitative toxicological data found.		

Short-chain fatty acids (propionic and butyric acids)

Effects	ppm	mg m^{-3}
Odour detection threshold Propionic acid Butyric acid	 0.024-20 0.00028-2.5	 0.084-60 0.001-9
No effects level: irritation of the eyes and nose (propionic acid)	2.1	6
Irritation of eyes and nose possible (propionic acid)	>10	>30

Trichloroethylene

Effects	ppm	mg m^{-3}
Odour detection threshold.	0.21-400	1.134-2160
Odour annoyance threshold.	161	864
Headache, sluggishness, dulling of senses, dizziness, nausea and vomiting.	50-100	270-540
Light anaesthesia.	5000	27000
Deeper anaesthesia.	20000	108000

Volatile Organic Compounds (VOC) I: Phenol and derivatives (phenol, cresols – mixed isomers and xylenol – mixed isomers)

Effects	ppm	mg m^{-3}
Odour threshold (phenol) Odour threshold (cresol)	0.04-5.8 0.00028-5	0.16-22.4 0.0012-220
No adverse effects in exposed workers (phenol)	5	19
Respiratory toxicity on prolonged exposure (phenol)	25	95
Immediate risk of death (phenol) Immediate risk of death (cresol)	250 250	950 1100

VOCs II: Toluene and derivatives (toluene, xylene - mixed isomers and styrene)

Effects (Carbon disulphide unless otherwise stated)	ppm	mg m^{-3}
Odour detection threshold Toluene Xylene Styrene	 2-40 0.08-40 0.05-202	 8-150 0.35-174 0.2-860
Headache and mild transiet irritation of the respiratory tract (toluene).	100-200	377-754
Nasal and eye irritation (styrene).	300	1280
Drowsiness, nausea, headache, fatigue, and dizziness (styrene).	200-700	850-3000
Euphoria, giddiness, tremors, nervousness, insomnia, headache, diszziness, fatigue, drowsiness, confusion, vertigo, increased reaction time, mild eye irritation.	400-800	1507-3015
Effects on reaction time (xylene)	450-900	1950-3900
Loss of muscle control, severe fatigue (toluene)	>800	>3015
General anaesthesia (toluene) Light anaesthesia (xylene) Death (styrene)	>10000 5000 5000	>37684 21700 21400

Table A1.5 Additional odour threshold values of common odorants

Compound	mg m^{-3}	ppm	Compound	mg m^{-3}	ppm
Acetic acid	0.043	0.016	2-Hydroxyethyl acetate	0.527	0.114
Acetic anhydride	0.0013	0.00029	Light fuel oil	0.053	Acetone
13.9	4.58	3-	Methylbutanal	0.0016	0.0004
Acrylic acid	0.0013	0.0004	2-Methyl-1-butanol	0.16	0.041
Amyl acetate	0.95	0.163	Methyldithiomethane	0.0011	0.00026
iso Amyl acetate	0.022	0.0038	2-Methyl 5-ethyl pyridine	0.032	0.006
Benzene	32.5	8.65	Methyl methacrylate	0.38	0.085
1,3-Butadiene	1.1	0.455	3-Methoxybutyl acetate	0.044	0.007
1-Butanol	0.09	0.03	1-Methoxypropan-2-ol	0.0122	0.003
2-Butanol	3.3	1	1-Methoxy-2-propylacetate	0.0075	0.0014
2-Butanone (MEK)	0.87	0.27	2-Methyl-1-pentanol	0.096	0.021
Butoxybutane	0.03	0.005	2-Methyl pentaldehyde	0.09	0.02
2-Butoxyethanol	0.0051	0.00097	4-Methyl-2-pentanone (MIBK)	0.54	0.121
2-Butoxyethyl acetate	0.045	0.0063	2-Methyl-2-propanol	71	21.46
Butoxypropanol	0.191	0.0324	α-Methyl styrene	0.021	0.003
Butyl acetate	0.047	0.0066	1-Nitropropane	28.2	7.09
2-(2-Butoxyethocy)ethanol	0.0092	0.0013	1-Octene	0.33	0.066
2,2-butoxyethoxyethyl acetate	0.015	0.0016	2-Octene	0.5	0.1
Carbon tetrachloride	280	40.73	2-Octyne	0.03	0.006
Carbon sulphide	0.0275	0.0102	2,4-Pentanedione	0.045	0.01
m-Cresol	0.0013	0.0003	1-Pentanol	0.02	0.0051
o-Cresol	0.0028	0.0005	Petroleum naptha	0.2	
p-Cresol	0.0029	0.0006	Phenyl ether	0.0021	0.0003
Cyclohexane	315	83.8	2-Picoline	0.014	0.0034
Cyclohexanone	0.083	0.019	Propanal	0.014	0.0054
Dichloromethane	3.42	0.912	2-Propanol	1.185	0.442
Diesel	0.06		2-Propen-1-ol	1.2	0.47
Dimethyl adipate	7.101	0.913	iso Propylamine	0.158	0.06
Dimethyl glutarate	1.212	0.169	Propylbenzene	0.048	0.009
Dimethyl succinate	0.992	0.152	Propylene-n-butylether	0.206	0.01
1,4-Dioxane	30.6	7.78	Propyl ether	0.024	0.0053
1,3-Dioxolane	56.3	17.02	Styrene	0.16	0.0344
Diphenylmethane	0.41	0.55	1,1,2,2-Tetrachloroethane	1.6	0.21
Ethoxypropanol	0.161	0.035	Toluene	0.644	0.16
Ethoxypropyl acetate	0.0052	0.0008	Trichloroethylene	8	1.36
Ethyl acetate	2.41	0.61	Trimethylamine	0.0026	0.001
Ethyl alcohol	0.28	0.136	Xylene (mixed)	0.078	0.016
2-Ethyl-1-butanol	0.07	0.015	2,3 Xylenol	0.0037	0.0007
2-Ethyl-1-hexanol	0.5	0.086	2,4 Xylenol	0.064	0.0117
2-Ethylhexyl acrylate	0.6	0.073			
2-Furaldehyde	0.25	0.058			
1-Hexanol	0.005	0.0011			
Hydrogen sulphide	0.00076	0.0005			

Source H4: Odour threshold values of common odorants

Other sources of threshold values
Compilation of odour threshold values in air and water, Central Institute for Nutrition and Food Research, TNO, Netherlands, June 1997. Editors: van Gembert L J; Nettenbrejer A H.
Compilation of odour and taste threshold values data, American Society for Testing and Materials, ASTM Data Series DS 48A. Editor: Fazzalari F A.

The documents above contain odour threshold values for a much wider range of substances. The fact that a document is listed does not necessarily mean that the values given are consistent with other documents, and it is advisable to cross-check values with more than one source as there can be considerable variation. This list is not exhaustive and other published values exist.

Table A1.6 :Hedonic scores 1 – negative scores

Description	Hedonic score	Description	Hedonic score	Description	Hedonic score
Cadaverous (dead animal)	-3.75	Stale	-2.04	New rubber	-0.96
Putrid, foul, decayed	-3.74	Fishy	-1.98	Metallic	-0.94
Sewer odour	-3.68	Musty, earthy, mouldy	-1.94	Wet paper	-0.94
Cat urine	-3.64	Sooty	-1.69	Medicinal	-0.89
Faecal (like manure)	-3.36	Cleaning fluid	-1.69	Chalky	-0.85
Sickening (vomit)	-3.34	Kerosene	-1.67	Varnish	-0.85
Urine	-3.34	Blood, raw meat	-1.64	Nail polish remover	-0.81
Rancid	-3.15	Chemical	-1.64	Paint	-0.75
Burnt rubber	-3.01	Tar	-1.63	Turpentine (pine oil)	-0.73
Sour milk	-2.91	Disinfectant, carbolic	-1.60	Kippery-smoked fish	-0.69
Stale tobacco smoke	-2.83	Ether, anaesthetic	-1.54	Fresh tobacco smoke	-0.66
Fermented (rotten) fruit)	-2.76	Burn, smoky	-1.53	Sauerkraut	-0.60
Dirty linen	-2.55	Burnt paper	-1.47	Camphor	-0.55
Sweaty	-2.53	Oily, fatty	-1.41	Cardboard	-0.54
Ammonia	-2.47	Bitter	-1.38	Alcoholic	-0.47
Sulphurous	-2.45	Creosote	-1.35	Crushed weeds	-0.21
Sharp, pungent, acid	-2.34	Sour, vinegar	-1.26	Garlic, onion	-0.17
Household gas	-2.30	Mothballs	-1.25	Rope	-0.16
Wet wool, wet dog	-2.28	Gasoline, solvent	-1.16	Beery	-0.14
Mouse-like	-2.20	Animal	-1.13	Burnt candle	-0.08
Burnt milk	-2.19	Seminal, sperm-like	-1.04	Yeasty	-0.07
				Dry, powdery	-0.07

Table A1.7: Hedonic scores 2 – positive scores

Description	Hedonic score	Description	Hedonic score	Description	Hedonic score
Cork	0.19	Crushed grass	1.34	Maple syrup	2.26
Black pepper	0.19	Celery	1.36	Pear	2.26
Musky	0.21	Green pepper	1.39	Caramel	2.32
Raw potato	0.26	Tea leaves	1.40	Coffee	2.33
Eggy (fresh eggs)	0.45	Aromatic	1.41	Meaty (cooked, good)	2.34
Mushroom	0.52	Raisins	1.56	Melon	2.41
Beany	0.54	Cooked vegetables	1.58	Popcorn	2.47
Geranium leaves	0.57	Clove	1.67	Minty, peppermint	2.50
Grainy (as grain)	0.63	Nutty	1.92	Lemon	2.50
Dill	0.87	Coconut	1.93	Fragrant	2.52
Woody, resinous	0.94	Grapefruit	1.95	Fried chicken	2.53
Soapy	0.96	Perfumery	1.96	Cinnamon	2.54
Laurel leaves	0.97	Peanut butter	1.99	Cherry	2.55
Eucalyptus	0.99	Spicy	1.99	Vanilla	2.57
Molasses	1.00	Banana	2.00	Pineapple	2.59
Incense	1.01	Almond	2.01	Apple	2.61
Malty	1.05	Sweet	2.03	Peach	2.67
Caraway	1.06	Buttery, fresh butter	2.04	Violets	2.68
Soupy	1.13	Grape juice	2.07	Fruity, citrus	2.72
Bark, birch bark	1.18	Honey	2.08	Chocolate	2.78
Anise (liquorice)	1.21	Cedarwood	2.11	Floral	2.79
Oak wood, cognac	1.23	Herbal, green, cut grass	2.14	Orange	2.86
Seasoning (for meat)	1.27	Cologne	2.16	Strawberry	2.93
Leather	1.30	Fresh green vegetables	2.19	Rose	3.08
Raw cucumber	1.30	Fruity, other than citrus	2.23	Bakery (fresh bread)	3.53
Hay	1.3.1	Lavender	2.2.5		

Source H4:

References

Dravnieks A, Masurat T, Lamm R A, *Hedonics of Odours and Odour Descriptors*: in Journal of the Air Pollution Control Association, July 1984, Vol. 34 No. 7, pp 752-755
Guidance for the regulation of odour at waste management facilities (H4 2002)

Appendix 2: Extract from the statutory code of practice on control of odour from waste water treatment plants

The following text is a direct extract from Statutory Code of Practice on Odour Control of Odour from Waste Water Treatment Plants (2006). The Code of Practice can be found on the Scottish Government website at: www.scotland.gov.uk/Publications/2006/04/20140331/0

Odour Risk Assessment Matrix
This appendix contains a method for ranking the impact of odours from waste water treatment plants and can be used as a confirmation or supplemental to other odour impact assessments for other industrial sources. The suggested criterion of 1000 is used in relation to WWTPs. This method must not be used in isolation of other assessment methods.

Some of the terminology used is slightly different to that used in this guidance and definitions have been provided.

Full details on how to use the matrix can be found in the Statutory Code of Practice.

Complainants

Weighting	A Radius	B Frequency (per annum)	C Nature & Strength	D Persistence	E Sensitivity	F Complaints
1	>1000m	<1	-	Sporadic 'whiffs'	Commercial and industrial	<1
5	<1000m>750m	1	Very faint	-	Isolated housing (<5 in 250m)	1
10	<750m>500m	2	Weak –unable to identify character	Sporadic	Scattered housing (>25 in 250m)	2
25	<500m>250m	4	-	Mildly Persistent	Outdoor recreational amenity (i.e. golf courses)	5
50	<250m>150m	8	Medium –able to identify source	Persistent	Established housing	10
100	<150m>100m	12	Strong – unpleasant	Very Persistent	Shops restaurants tourist resort	20
200	<100m>50m	20	Very strong – unpleasant	-	Schools	30
350	<50m>25m	30	-	Continuous	-	40
500	<25m	>30	-	-	Hospital	>40

Definition of terms used in Risk Assessment

Odour radius
This is an expression of the maximum distance of complaint from the site based upon either actual data from complaint records or modelled data from dispersion predictions.
Consideration should be given to the degree of confidence in complaints (for example whether the presence of the odour has been independently witnessed). In cases where there is uncertainty about the justification for a complainant at a much distance from the works than the majority of complaints the distance used should be midway between the furthest and next furthest complainant.

Odour Frequency
This is a measure of how often odours clearly perceptible odours are detected beyond the site boundary. Again it may be necessary to adjust this number where isolated complaints are not validated. It is intended not as a measure of the number of complaints but of the number of odour occurrences which result in complaint (for example if there are 20 complaints over two days when odours are attributable to a plant malfunction this would be one occurrence). Where complaints are due to a continuous odour over a significantly protracted period, a minimum frequency of 20 should be used.

Odour Intensity
This is expressed as the product of the odour nature and strength and the persistence.

Odour Nature and Strength
This is a self-explanatory characteristic. It refers to both the subjective strength and the 'unpleasantness' of the odour. It acknowledges that odours are often more intrusive when the source can be clearly identified from the characteristic smell.

Odour Persistence
This is again a simple subjective scale and reflects how easily the odour dissipates when released (or how long the odour tends to remain detectable in an area after release).

Sensitivity of Receptors
This takes account of adjacent land-use and the sensitivity of use ; for example odours adjacent to a hospital or nearby a major tourist attraction would be given greater weighting than industrial or commercial uses. In general the presence of an odour sensitive use within 150 metres of a works (except housing which has a specific distance rating) should be taken as relevant for this characteristic. Obviously, if the odour radius is more than 150 metres and there is a sensitive use within the odour radius which is affected by the odour, the sensitive use rating should be used.

Number of Complainants
This characteristic combined with the odour frequency gives an expression of the potential extent of the nuisance impact of the odour. This should be expressed as the total number complainants from justified complaints are received in a year;

Odour Rating
Whilst the intention of this matrix is not to specify an odour rating above which a nuisance can be assumed, it is a very useful tool is assessing the steps proposed to control odours and also for determining the degree of success of measures taken in mitigating nuisance.
The suggested calculation to determine the odour rating using the weightings from the above table is as follows:-

Odour Rating (O_R) = (((Frequency x Complaints) x Sensitivity)/ Radius) x ((Intensity)/Radius)

Where Intensity = (Nature & Strength x Persistence)

This can also be expressed as:-

$OR = (B \times C \times D \times E \times F)/A^2$

Whilst the use of a simple rating system cannot accurately determine nuisance due to the number of characteristics which influence the assessment, it is suggested that OR values above 1000 indicate likely nuisance. However values below this do not necessarily indicate the absence of nuisance. The following examples illustrate the use of the Odour Rating Matrix.

Example 1
A WWTW is located in a town centre location with a school within 250 metres and shops within 300 metres and established housing within 50 metres. Complaints have been received for over 4 years and the furthest complaint was 300 metres from the works. However all other complaints were within 100 metres and there is some uncertainty over the validity of the furthest complaint. Hence the odour radius has been assumed to be 150 metres. There are typically 4 or 5 occurrences every year and these result in 45 complaints from 5 complainants. The odour has been described as weak and was indiscernible (not able to identify source) and was mildly persistent. Based upon the Odour Rating Table the following weightings apply:-

	Parameter	Weighting
Odour radius (A)	**150m**	**100**
Odour Frequency (B)	**4 per annum**	**25**
Odour Nature and Strength (C)	**weak indiscernible**	**10**
Odour Persistence (D)	**mildly persistent**	**25**
Sensitivity of Receptors (E)	**established housing**	**50**
Number of Complainants (F)	**5**	**25**

The Odour Rating is as follows:-

$OR = (25 \times 10 \times 25 \times 50 \times 25)/100^2 = 781$
This suggests that the odour does not constitute a nuisance.

Example 2
A WWTW is located in a village with a school within 50 metres and shops some 400 metres away and established housing within 50 metres. Complaints have been received for over 4 years. The furthest complaint was 100 metres from the works and there are typically 6 occurrences every year and this results in 10 complaints from 4 complainants. The odour has been described as string and unpleasant and was persistent. Based upon the Odour Rating Table the following weightings apply:-

	Parameter	Weighting
Odour radius (A)	**100m**	**200**
Odour Frequency (B)	**6 per annum**	**25**
Odour Nature and Strength (C)	**strong unpleasant**	**100**
Odour Persistence (D)	**persistent**	**50**
Sensitivity of Receptors (E)	**school**	**200**
Number of Complainants (F)	**4**	**10**

The Odour Rating is as follows:-

$O_R = (25 \times 100 \times 50 \times 200 \times 10)/ 200^2 = 6250$

This suggests that the odour does constitute a nuisance.

Appendix 3: odour complaint checklist and guidance

This guidance note has been produced to assist EPI officers who may be asked to deal with odour complaints. It comprises a complaint response flow diagram, a checklist of information to be recorded during any odour investigation, and some commonly used odour descriptors. The need to attend a complaint or incident should be determined in line with SEPA's standby guidance on Q-Pulse taking into account the specific circumstances.

It should be remembered that we only regulate odour emissions from PPC and WML (including registered exempt) installations/activities. All other odour complaints should be directed to the relevant local authority. Be aware that odours can have a strong emotive impact on those affected, particularly when it causes nausea, or restricts enjoyment of an amenity eg having to close windows or preventing the use of gardens.

Remember that odours can be pleasant/acceptable to one person but offensive to another, and that individuals can be sensitized or desensitized to certain odours – in particularl site operatives and/ or investigating officers can become 'used to' an odour.

The overall offensiveness of an odour depends on a combination of factors, and information on all of these factors needs to be considered to reach a final conclusion, as follows:

Frequency of occurrence (one-off, few/ several occurrences?)
Intensity of odour (faint, strong etc)
Duration of odour event (length of time of event, continuous, sporadic, whiff?)
Offensiveness/ annoyance (odour character, ie inherent 'unpleasantness' of the smell)
Location (sensitivity of receptors, weather conditions)

Although you may be visiting the affected area for only a short time, it is important to ensure that information is collected to aid in determining whether or not any detectable odour is "offensive", including any period that an odour may have been present before or after the investigating officer leaves the area. The complainant should be asked specific questions about the frequency and duration any odour event has been occurring and what impact it is having on them. It may be appropriate to seek to take a statement from a complainant, normally after the odour event has been addressed.

An odour investigation recording form is available on QPulse to assist in capturing this information (copy attached at end of this Appendix).

This form should be used when undertaking follow up investigations or where there are specific circumstances requiring more information to be recorded. The standard ELMS event form can be used in conjunction with the table below for initial responses to new events or where the source etc can be easily identified and assessed.

Information to be recorded includes the following specified in Table A3.1 (some of this information is normally recorded for other types of incidents and is repeated here for completeness).

Table A3.1: Summary of actions/information required

On receipt of complaint	Complainants name and address.	Can complainant smell odour at present (date and time)?	How long has odour been noticeable to complainant?
Complainant's description of odour intensity and character.	Has complainant had to change normal behaviour (shut windows, leave garden etc) or reported any health effects (nausea, headaches etc)?	Is anyone else known to be affected (neighbour, other member of household)?	Has complainant contacted anyone else (EHO, police etc)?
Suspected odour source (premises); may be more than 1?	Is this a repeat event? (summary of previous events).	Any other complaints likely associated with this event (time, location)?	
On arrival in area	Weather conditions – wind speed/ direction, wet/dry, temp.	Location of each assessment position.	Is source of odour obvious (check upwind to confirm)?
Time spent at each assessment position	Odour character, intensity, duration at each location.	What is extent and sensitivity of area affected (housing, commercial, schools etc)?	
On visiting suspected source site	Suspected odour source (vent, waste storage area etc) Note potential sources/ activities.	Does operator have any explanation (eg new waste type, maintenance fault)?	Operator proposals for short term resolution?

The intensity, duration and character of an odour should be assessed at a number of locations around the source, along with the sensitivity of each assessment location. Other potential odour sources in the vicinity should be noted and the observation period during any assessment at each location should be similar. The actual amount of time required will be dependent on the circumstances and could be a little as a few minutes where the odour is easily recognisable and up to 30 minutes to identify/corroborate faint or transient odours. In cases where the odour is considered to be offensive the time required for assessment should be the minimum necessary so that actions to stop the release can be initiated as soon as practicable. Assessment locations should include upwind of the suspected source (as the first location), then the complainant location(s), any other downwind locations, and at the site boundary (at and/or within site boundary assessments should be undertaken last).

A sketch plan of the assessment locations, source site, local topography and wind direction is useful (plus any special weather conditions such as coastal fog, haars etc). Plotting complaint and possible source locations on a street map may be helpful especially if responding to multiple complaints or repeat incidents. It may be appropriate to track down an odour source by tracking back from the point of impact or complaint to a potential source.

Frequency, intensity, duration and location (FIDOL) can be recorded using an assessment system as indicated below.

Frequency relates the number of events, which could be repeat events on the same day and can be defined from 1 - 5 as follows:

1 Rare, perhaps first recorded occurrence;
2 Infrequent, 2 or 3 events per year;
3 Occasional, 1 or 2 per month; or several short duration events in any one day;
4 Frequent, 1 or 2 per week; or routine short duration events over same period;
5 Very frequent, perhaps 3 or more events per week or numerous/repeated short duration events over same period.

Intensity categories may be defined from 1–5, as follows:

1 No detectable odour
2 Faint (need to inhale facing into wind)
3 Moderate (easily detected while breathing normally, possibly unpleasant character
4 Strong (bearable but distinctly unpleasant odour)
5 Very strong (very unpleasant odour, possibly causing nausea).

Duration categories may also be defined from 1- 4 as follows:

1 Transient, e.g. whiff (only detectable for brief intermittent spells)
2 Sporadic discrete <5 to 10 minutes or <50% of total assessment time if less than 30 minutes
3 Persistent greater than 50% of assessment time but not continuous, fairly localised
4 Continuous, present throughout assessment period.

Location categories may also be defined from 1–5 as follows:

1 On site or at boundary only
2 Short distance from boundary but not impacting any sensitive receptors (<25m)
3 At nearby sensitive receptors (<250m)
4 In wider locality out with immediate area of site (<500m)
5 Widespread, affecting large areas.

Sensitive receptors include housing, schools, hospitals, commercial premises (such as restaurants, offices, shops etc) and outdoor recreational space. Table A2.1 gives weighting factors used for receptors/location sensitivity in the waste water treatment statutory code which can be used as a guide in odour incident assessment.

Wind speed/Direction may be measured using an appropriate instrument or estimated using, for example, the Beaufort 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

Assessment of offensiveness

Offensive character descriptors will be subjective, and if two SEPA officers are attending the event they should both attempt to agree on the same odour descriptor at a particular location. The descriptor may however, change between locations due to chemical behaviour characteristics. Table A1.1 may be useful for officers and complainants in describing the odour(s).

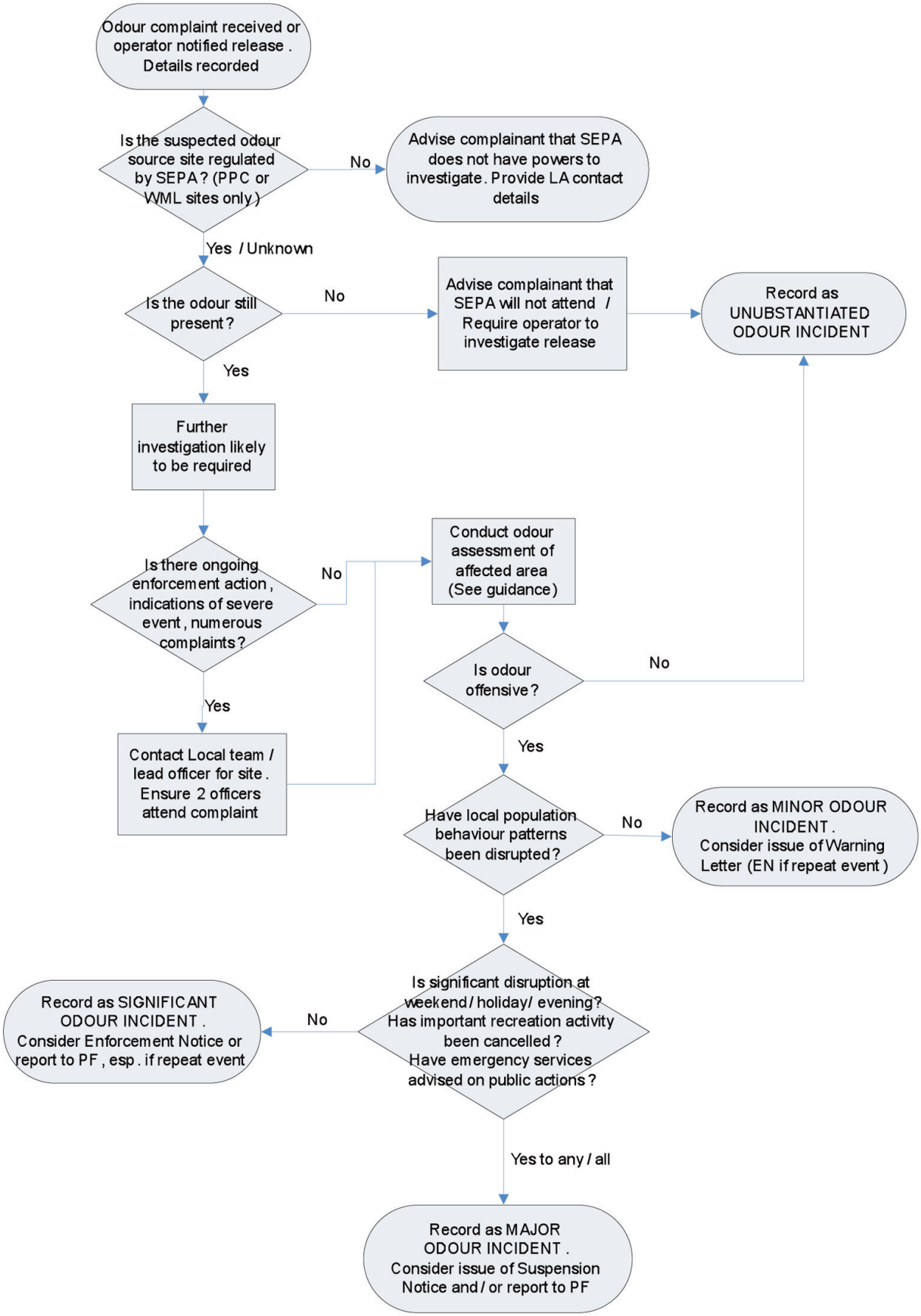
Overall assessment
Taking into account the FIDOL factors described above an officer should come to a conclusion regarding the presence and offensiveness of the odour. For each assessed location It is essential that the officer provides an opinion as to whether or not any odour if present and is considered to be offensive or not. The officer should also give an indication of whether the complaint/event, if offensive, can be classified as either a major, significant or minor odour event or as an unsubstantiated odour event. The following statement examples might be of assistance.

	Statement examples
a)	There is a record of repeat odour events at these locations.
b)	The odour cannot be detected.
c)	The odour can be detected, has some low offensive characteristics and is infrequent and is therefore unlikely to be offensive. However it may be offensive if it is more frequent or of longer duration etc.
d)	The odour can be detected but is not offensive unless it is continuous.
e)	The odour is moderate, has offensive characteristics and is sporadic impacting on a sensitive receptor and should be considered to be offensive.
f)	The odour is moderately strong and is offensive if it is continuous or if its occurrence is very frequent.
g)	The odour is strong and has offensive characteristics. Although it is infrequent and over a short duration it should be considered to be offensive

Given the number of FIDOL factors and potential combinations it is for the officer undertaking the assessment to come to an overall view of the nature and impact of any odour and provide a summary statement along the lines given in the examples provided here.

A flow diagram to assist in the classification of an odour incident, and potential follow-up action is provided below. If the odour event is likely to lead to enforcement action, it is preferable that two authorised SEPA officers attend the complaint and undertake the assessment for corroboration purposes.

Flow diagram for Odour Incident Investigation and Classification



Odour investigation form

Location Code		**File Ref**		**Date**		**Time**	

Name and signature of Officer 1					
Name and signature of Officer 2 (if appropriate)					
A (Odour absent)		**B** (Odour detected)		**C** (Odour offensive)	

Complaint details

Complainant name		Complainant address	
Location of complaint			
Time and duration of odour		Date and time complaint received	
Reported effect of odour on complainant*		Suspected odour source (site)	
Other related complaints received?		Has complainant contacted anyone else (police, EHO)	

* Has the complainant reported any ill-effects which may be due to the odour (eg nausea) or had to take actions to reduce odour impacts (eg shut windows, go inside).

Location details

Weather		Wind speed and direction	
Temperature		Air pressure (if known)	
Distance of housing from suspected source		Other sensitive receptors in area (and distance)	

See the wind strength descriptors (Beaufort scale) above.

Assessment 1: frequency

Any known information on event frequency (See frequency categories above)

Comments:

Map/sketch plan of area under investigation

A map or sketch plan could show rough outline of suspected odour source site, location of complainants' houses, odour recording locations, wind direction, plume direction and extent and any other relevant details. If performing assessments at multiple locations, you may only need one plan showing the whole area.

Assessment 2: odour intensity, duration and character

Stand at the selected locations. This should include outside the complainant's property and immediately upwind and downwind of the suspected source (do upwind location first). Use the table below to record your observations with respect to odour strength over a period of up to 30 minutes (length depends on intensity of odour). The odour strength can vary quickly in short periods of time. Record your observations by tallying the number of times odours of different intensity are experienced during each period. Complete a new table and summary statement for each assessment location.

Location	Odour intensity and duration						Start time
	1–5 mins	6–10 mins	11–15 mins	16–20 mins	21–25 mins	26–30 mins	Odour description
Very strong							
Strong							
Moderate							
Faint							
No Odour							

See guidance above for odour strength categories (1–5) and duration descriptors, and for terms which may be useful in describing the odour characteristics.

Assessment 3: offensiveness at this location

Summary statement of odour situation at this location (See odour guide for example statements)	Offensive? (Yes/no)

Appendix 4: odour control techniques

This appendix provides an outline of available techniques for controlling odour from both new and existing regulated sites. It is not intended to be an exhaustive source but aims to provide an introduction to the general principles of odour control and should be used in conjunction with other available guidance[15]. Reference material used in the creation of this guidance and further information sources providing greater detail on specific techniques are provided throughout.

This guidance examines the opportunities available for the elimination and minimisation of potentially odorous substances or activities through the design, operation and management of site operations before examining the identification and assessment of the odour treatment the techniques available for fugitive and point source releases. A short summary of the description, design considerations, common uses, advantages, disadvantages and common issues encountered is provided for each of the odour treatment techniques examined. A brief discussion is then given to the selection of techniques and issues to be considered during inspection.

This guidance has been divided into the following sections:

Management and design

- Design and process integrated measures
- Management – odour management plan
- Odour management plan template

Fugitive and diffuse emissions

- Management and control
- Containment and capture
- Dispersion and dilution
- Neutralisers and masking agents

Ducted and point source emissions

- Biological treatment
- Incineration
- Adsorption
- Dry chemical scrubbing
- Absorption – wet gas scrubbing

Open systems

- Landfill
- Composting
- Land spreading
- Coating

Techniques that may be used in an emergency situation

- Provision for emergency techniques
- Technical options available

[15]There are many sources of technical information on the selection of equipment to treat waste gas emissions containing odorous substances. This guidance draws on Chapter 4 of H4 Part 2. More detailed guidance including relative costs can be found in BAT Reference (BREF) documents for specific industrial sectors. Section 4.6 of the BREF note on Waste Industries provides a good round up of available techniques and can be found at http://eippcb.jrc.ec.europa.eu/reference/

Management and Design

Design and process integrated measures

The greatest opportunity for any pollution prevention (including odour) arises during the early stages of project inception. As the project progresses through the various stages of route selection, design and build, the options available to reduce pollution become fewer. It is therefore essential that the applicant considers and addresses all relevant environmental issues as early as possible within the design process.

It is also essential that once designed and built, the process is operated and managed in a way that not only minimises the potential release of odorous emissions but continually reviews site practice in order to identify further options for the elimination and minimisation of potential odorous substances and activities.

Though this guidance is aimed at the consideration of available opportunities for the control of odour, it is noted that odour is only one environmental aspect and as such cannot be considered in isolation. Therefore you should bear in mind the effect on all environmental media and consult further guidance on the assessment of all such aspects.

While the above generally applies to new plant, scope does exist for consideration of the design of existing plant eg when an operator considers plant upgrades or where there is an unacceptable release of odorous emissions from the site.

In new plants, preventive control measures, in-plant segregated waste stream treatment and/or process-integrated measures can be effectively taken into account in the design stage of the plant. For existing plants, retrofitting to existing installations and infrastructure will generally be more expensive and may involve technical and organisational constraints.

Management – odour management plans

Odour management should be considered alongside, and integrated with, other aspects of the plant management systems. Management measures for the control of odour should include:

Commitment

- corporate policy commitment
- senior management statement

Training

- methods;
- frequency
- training records.

Procedures

- operating procedures;
- contingency procedures;
- identify the odour complaint recording and investigation procedure.

Monitoring and supervision

Identify parameters that need to be monitored. This should include parameters to:

- help avoid the creation of potentially odorous emissions (process temperature/pressure);
- ensure destruction of potentially odorous emissions (temperature in an oxidiser, flow/pH through a scrubber etc); or
- reduce impact from potentially odorous emissions (weather station).

Each parameter requires active supervision to ensure that the odour management plan is being implemented and is effective.

Records

Identify what records need to be kept ie weather monitoring, process monitoring, action taken, complaint investigation etc.

Specific actions as detailed in an odour management plan

All sites with the potential to generate odours should have an odour management plan, which essentially details all of the potential odour sources, any actions required to reduce or prevent these potential odour releases and, if there is an ongoing odour issue, the expected date of completion and the person responsible for rectifying the problem.

The scope and level of detail of an installation odour management plan will depend on the nature of the activities being undertaken. The plan should be updated regularly. Development of a simple odour management plan (eg for a farm) may include the following:

Identification of corrective action

Identify the sources of odour and/or complaint on your installation: Carry out an assessment 'walk around' to identify where odours are coming from. 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. During the walk around think about where odours come from and under what circumstances eg:

- How much does odour increase during occasional operations such as raw material delivery, equipment cleaning and removal of waste? Are complaints related to these activities?
- Are there waste storage areas? Are these covered or uncovered? Where are they located in relation to local houses?
- Are there spills, leaks or deposits of raw or waste materials on floors or external yards or roadways?
- Are there uncovered skips or bins?

Spend at least 3 minutes at the point(s) nearest to housing and, if odour is detectable, record the intensity and extent of the odour. This may use the scales (1¬–5 for intensity and 1–5 for extent) described in Appendix 3 of this document. The results should be recorded against the time and date and the appropriate monitoring location. The name of the person undertaking the assessment should be recorded. The cloud cover, wind direction and wind speed should also be noted

Look at the odour sources and consider if there are any corrective actions which can be undertaken to prevent or reduce the odour. Prioritise those sources or activities which do cause a problem on the installation and the types of corrective actions that you propose. Transfer the relevant information into the odour management plan, identifying each odour problem/source and corrective actions.

Identification and creation of procedures

Procedures may need to be created within the Odour manage plan for issues relating to odour release and should cover as a minimum; odour complaint investigation, spillage control and clean up, proactive area monitoring and contingency planning (account for breakdowns and seasonal variation in emissions). Site specific procedures may also be incorporated for issues such as material acceptance criteria.

If general procedures exist that cover these issues, such as general spillage control or complaint investigation, then reference should be made to them in the odour management plan.

Identification of responsible personnel

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), when the task is to be completed by and who is responsible for ensuring tasks are completed.

Review cycle

The plan should be reviewed periodically, with the period set dependant on the odour potential from the site (minimum review of at least every 4 years). The plan may also need to be reviewed following the receipt of complaints or after any corrective actions have been undertaken.

<table>
<tr><th colspan="4">Odour management plan template</th></tr>
<tr><td>Company name</td><td></td><td>Site/Environmental Manager</td><td></td></tr>
<tr><td>Address</td><td></td><td>Working hours (09:00 – 17:00)
Point of contact:-
Telephone number:-</td><td></td></tr>
<tr><td>Purpose</td><td>(Define the environmental effect being managed by the plan and the objective in relation to that effect)</td><td>Out of Hours
Point of contact:
Telephone Number:</td><td></td></tr>
<tr><td colspan="2">Location (Identify the site location, local sensitive receptors (including type), mark on the given plan)</td><td colspan="2">Process description (Briefly describe the activities carried out on site with relation to potentially odorous substances and processes carried out – described in greater detail in table below)</td></tr>
<tr><td colspan="2">Location plan</td><td colspan="2">Site plan</td></tr>
</table>

Odour source (process area)	Release points (Point Source/fugitive)	Failure events			Resultant actions (Responsible post) (record maintained)
		Scenario	Potential outcome	Preventative / mitigation measures (reference procedure)	
Raw material Reception/handling	**Point source**				
	Storage of XXX (tank vent)	Failure of filter due to break through.	Onsite odour Odour complaints	Filter arranged in parallel to allow switch over on unit	Stop filling operation and switch/replace filter
	Fugitive				
Next source	**Point source**				
	Fugitive				
Next Source	**Point source**				
	Fugitive				

Notes:

Odour sources
These describe the sources on site with relation to potentially odorous substances or activities carried out. This should be done in general terms with specific scenarios and events considered under failure events.

Release points
These should be split into 'Point Source' and 'Fugitive' releases as the two groups are often dealt with in a different manner.

Failure events
These describe the failure scenarios, potential outcomes and resulting odour mitigation systems in place. Under the prevention/mitigation measures the following should be identified:

- relevant operating/contingency procedures;
- parameters that need to be controlled and/or monitored in order to provide warning/minimise emissions;
- preventative maintenance regimes in place;
- inventory of mitigation equipment and materials/consumable spares;
- training in operation of plant, awareness of procedures and in the use of mitigation equipment.

Resultant actions
These describe the action that is to be taken (and the person responsible for taking the action) in order to minimise or stop the outcome identified. This should include reference to:

- relevant operating/contingency procedures;
- records to be maintained (should record the outcome and the action taken);
- training in operation of plant, awareness of procedures and in the use of mitigation equipment.

This should also identify regular review period and requirement for review of systems following incident.

Fugitive and diffuse emissions

Fugitive and diffuse emissions are generally considered as all those which are not captured and released through a specific and anticipated discharge point such as a chimney, ie any discharge which is not classed as 'point-source'. They can be difficult to deal with as they tend to be characterised by low concentrations (of odorous compounds), which may be emitted over a large area eg an open tank, and/or via numerous locations such as doors and windows.

Although vents are usually designed as a release point and as such are considered point-sources, emissions from some vents are often considered as fugitive, eg Local Exhaust Ventilation points (LEVs), tank breathing vents, emergency bursting disc/pressure activated vents, as discharges to atmosphere through these types of system are not controlled and/or expected on a regular basis.

Likely significant sources of fugitive emissions include:

- raw material handling and storage;
- open doors/windows and fabric of the building;
- waste storage;
- spills;
- abatement and process plant maintenance;
- doors, hatches and sampling points etc on process vessels;
- open tanks, uncovered skips and bins;
- tank filling (material being put into tank displaces vapours, dusts out through filling point or breathing vent);
- ill fitting connections, flanges, valves and leaking pipes/ducting.

Management and control of fugitive emissions

The following good practice techniques should be used for the reduction of fugitive odorous emissions:

- Maintain the integrity of process buildings by:
  - Careful selection of materials of construction. Poor selection of materials can lead to preferential corrosion and loss of containment. Fabric of the building should be inspected regularly.
  - Keeping windows and doors shut. Remotely operated roller doors can minimise the amount of time that doors are open or flexible industrial curtains can be used across doorways (if visual obstruction is not a problem). Siting doors at opposite ends of a building can create a through draft which carries odour out and should be avoided where possible. For very odorous processes the use of interlocked air-lock entry and exit doors and maintenance of negative pressure within process plant or within process buildings will prevent the escape of contaminated air. Implications for the health and safety of people working inside should be considered.

- In the case of open air operations, observe good practice relating to covering odorous materials, housekeeping, mixing of materials, venting, design etc.

- Transfer odorous materials in automatic flow demand systems rather than in batch containers where possible. Vapour balance lines should be installed for tanker loading or offloading of odorous materials and also for tank transfers. Tankers should use dry break couplings to minimise the potential for spillages. Where there are only occasional transfers of substances which have no environmental impact in air other than their odorous nature, it could be sufficient to move the loading point to the furthest point from the sensitive receptor.

- Cover tanks/lagoons of odorous material where possible. Where it is not possible to completely cover the tank it may be possible to use polypropylene hexagons or balls (chroffles) to reduce the surface area of the tank. This will reduce evaporative loss and odour and will also have the added benefit of reducing energy loss. Fill from the bottom with submerged pumps to avoid disturbing the surface.

- Maintain seals, glands, pumps and other potential fugitive release points within a planned programme of preventative maintenance and implement a leak test regime. The design specification for pumps, valves, pipe flanges, relief valves and bursting discs etc should be reviewed.

- Avoid mixing incompatible materials which may produce malodorous breakdown products.

- Ensure that raw materials, products and wastes are stored appropriately. The condition of incoming material may need to be monitored and acceptance criteria established whereby if the material is degraded to such an extent that any handling or processing is likely to result in the release of offensive odour then it is not accepted on to site. Generally putrescible materials should be rotated on a first-in, first-out basis and refrigerated where appropriate (there may be seasonal variation in the "shelf life" of putrescible materials). Care should be taken with regard to transit times. Where material has had longer to travel it may arrive in a more degraded state than material already on site and therefore should be processed first where possible.

- Avoid conditions which encourage anaerobic breakdown.

- Good housekeeping - avoid build-up of malodorous materials and wastes except in designated (and appropriately managed) areas.

- There may be opportunities to adjust operating times to avoid weekends or evenings, or to run a particular process only when the wind is favourable.

- Ensure that staff receive suitable and sufficient training relating to odour control.

Containment and capture

There are different types of containment: it can be local to part of a process or used for an entire process. Containment may be a step before treatment (capture) or may be able to stand alone as a means of preventing offensive odour from escaping the process or installation boundary.

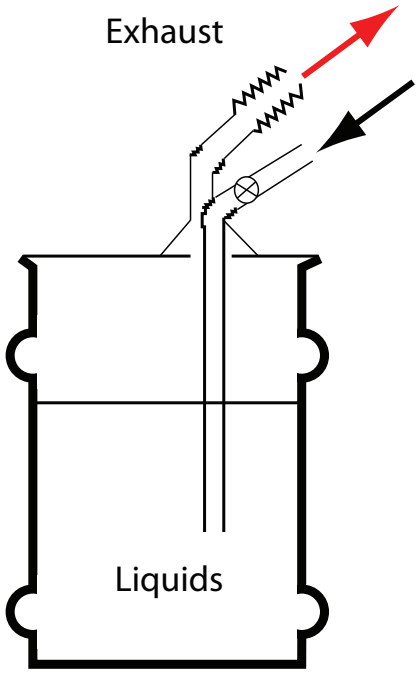
Containment can be achieved by eliminating unintentional holes in equipment, ducts, buildings etc including keeping doors and windows closed, avoiding the storage of odorous materials outside the building and the transport of materials between buildings in open containers etc. As a general rule all odour control systems should exert a negative pressure locally or within process buildings to prevent odorous air leaking out. Actions taken should not compromise the health or safety of those working inside.

The number of air changes per hour in a contained system such as a process building should be sufficient to ensure adequate capture of odorous substances. The need to reduce ambient odours within a building has to be balanced against the energy and operating costs associated with moving large amounts of air. The specific requirements need to be determined on a case by case basis and change greatly depending on activity and subject to seasonal variation for example with maggot breeding processes ventilation rates of between 10 air changes per hour in the winter and 25 air changes per hour in the summer are recommended. However, for most situations, a guideline minimum of 3 air changes per hour should be used.

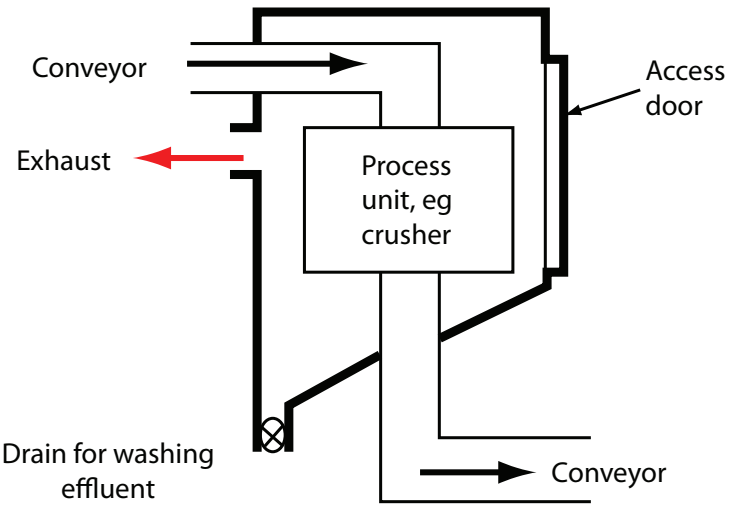
Odorous air should be contained within process machinery to avoid contaminating the much larger volumes of "ventilation air" within buildings. Good localised containment of intensely odorous process gas and effective treatment prior to discharge or to mixing with general ventilation air can remove the need for treatment of a much larger volume.

The release of odorous or other volatile substances – if these are to be expected – can be prevented by covering the vessel or operating in a closed tank and ducting (capturing) the exhaust air to a gas abatement system.

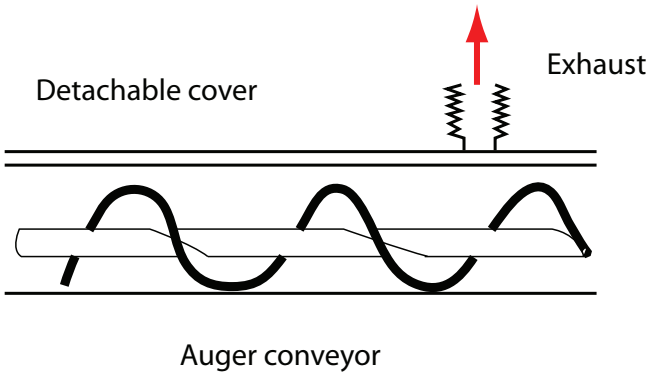
Various types of containment and capturing techniques are shown below.

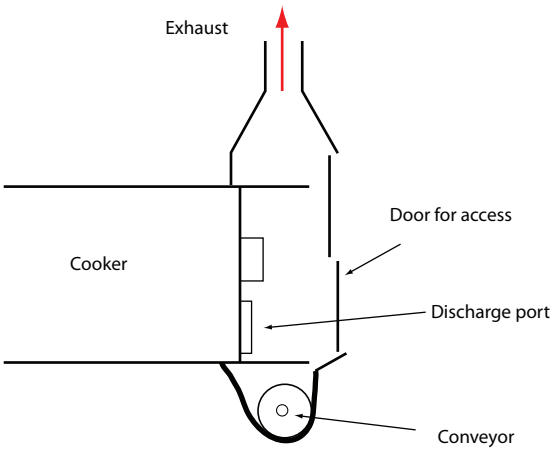


Drum filling



Processing unit





Rendering Cooker Discharge

REF:TGN IPPC H4, PART 2, OCT 2002

Design considerations

Install containment systems with sufficient collecting volume.

The overall cost of treating an odorous gas stream is determined to a large extent by the volume of air involved.

Common systems and uses

Fugitive/diffuse emissions:

- process emissions from the process equipment and inherent to the running of the plant, released from a large surface or through openings etc.
- non-ducted emissions (eg working losses and breathing losses, when not captured and ducted) from storage equipment and during handling operations (eg filling of drums, trucks or containers)
- non-routine emissions, resulting from operations other than the routine processing of the facility, including emissions during start-up or shutdown, and during maintenance
- secondary emissions, resulting from the handling or disposal of waste (eg volatile material from sewers, waste water handling facilities or cooling water).

Advantages	Disadvantages	Common problems/lessons
Containment of highly odorous process gases, ie keeping it separate from less odorous streams, may reduce the capital and operating (energy costs etc.) of the required abatement system(s). This also has the potential benefit of reducing raw material usage and waste generation.	Containment does not deal with the root cause/source. Can be difficult to identify and correct breaches in containment as and when they occur.	Some processes are obviously not amenable to enclosure, for example landfill and effluent treatment, although for the latter localised enclosure of some parts of the process may be possible. Where it is not possible to completely cover the tank it may be possible to use polypropylene hexagons or balls (chroffles) to reduce the surface area of the tank. This will reduce evaporative loss and odour and will also have the added benefit of reducing energy loss. Testing of buildings, tanks and storage areas using smoke generators can provide a quick and easy means of identifying holes and leaks from which odour may escape. Leak testing in this way often provides a very positive initial step in a programme to identifying odour sources, and can all help in creating a more efficient negative pressure system. Care should be taken when selecting the colour of the smoke used as it can be difficult to see white smoke on a grey day. It should also be noted that the smoke can take a tortuous path (travelling along internal walls) and exiting in unexpected areas. Management of the containment is very important. Doors will not stop odour if they are left open so self closing mechanisms should therefore be employed where possible and consideration given to fitting visual and audible alarms to activate when the door has been open for a specified period of time.

Dilution/dispersion

Dilution and dispersion are usually achieved via emission through a tall stack. A stack will be appropriate for very low intensity or non offensive odours, discharged at low rates and as a final step following treatment of an odorous gas stream.

Dilution
A common misunderstanding is that diluting odorous air prior to stack discharge minimises the potential for odour annoyance at sensitive receptors. Increasing the air volume will change the characteristics of the emission, such as increasing the exit (efflux) velocity, and therefore increase the effective stack height. This will have some effect on the dispersion characteristics of the emission, but dilution itself does not alter the mass odour emission. The perceived odour level at a given receptor point is more a function of odour mass discharged rather than the actual odour concentration. Therefore the released mass must be reduced to have any effect. Depending on other dispersion characteristics, increasing the effective stack height may simply result in changing the location of the area of impact.

Dispersion
Where odour cannot be prevented, containment and often some form of treatment is followed by release to atmosphere and reliance is placed upon sufficient dispersion taking place before sensitive receptors are reached.

Design considerations
The stack should be appropriately designed to ensure it is an adequate height above the buildings in the vicinity, and this may require dispersion modelling. As a general rule of thumb, the stack should be at least 2.5 times the height of adjacent buildings within a radius of 5 stack heights.

Exit velocity is an important consideration because increasing it will increase the effective stack height and so change the dispersion characteristics of the plume. The following general rules of thumb are highlighted for information:

- Downwash: if the ratio of wind speed to exit velocity is too low then emissions can be drawn down the stack and ground on site. To avoid this, the exit velocity should be at least 1.5 times the wind speed.

- Exit velocity can be considered to be comprised of two components; a momentum element and a buoyant (temperature dependant) element.

  - Momentum effects last approximately 30 to 40 seconds and can be increased by either increasing the volumetric flowrate of the discharge or restricting the stack diameter (addition of cone accelerator).

  - Buoyancy effects last approximately 3 to 4 minutes or until the temperature of the plume matches the ambient air temperature.

  A rough rule of thumb for dominant effect is that if the exit temperature is around 10 to 15°C higher than the ambient air then buoyant rise will be greater than that due to momentum.

- There should be an unrestricted final discharge (ie hooked vents or rain caps that restrict flow should be avoided).

Knowledge of what constitutes an acceptable level of exposure can be used in calculating a suitable chimney height for dispersion of residual odours. Concentration is one of the factors that determine the impact of a given odour on sensitive receptors.

Odour exposure criteria are a statistical means of linking the odour emission from a process to the impact (concentration) at ground level, in terms of probability of occurrence, taking frequency of occurrence into account. They are determined by mathematical dispersion modelling of source emission data and other local data.

They are probability-based and therefore are not absolute "limits"; they are merely indicative of an average concentration that is likely to occur for a specified percentage of the time over a year. Section 2.3 in this document describes the use of limits

Common systems and uses:
The rules of thumb described above and below have been highlighted to provide an initial impression only. 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. Dispersion modelling attempts to describe the effects of atmospheric turbulence on the emission(s) as they undergo dilution and dispersion in the surrounding environment.

Advantages	Disadvantages	Common problems/lessons
Dispersion has a moderate capital cost but low running costs. Odour dispersion modelling is one of the only tools that can predict the potential effects of a new odour-emitting activity.	The magnitude and frequency of the peaks in concentration are often the factors that determine whether an exposure is acceptable or not. Odours can be detected at low levels and can have an impact over a very short period of time. Simply building a tall chimney does not guarantee that there will be no impact from the release of odours as this will be dependent on a number a factors not least the weather and local topography. The amount of the odorous substance in the waste gas should be minimised by the use of effective abatement techniques prior to discharge to the atmosphere.	Increasing the effective chimney height may reduce or eliminate complaints close to source but may not reduce complaints further afield. Complaints from further afield may actually increase with increased effective chimney height if dispersion is poor. Reducing the mass emission is often more effective than increasing the chimney height. Typically the maximum ground level concentration will occur between 10 and 20 stack heights down wind of a stack. The maximum ground level concentrations are inversely proportional to the square of the stack height. The rate of release of the odorant governs the maximum ground level concentration not the final concentration in the stack.

Masking compounds and neutralising agents

Masking compounds and neutralising agents are products available for treating fugitive odours such as from landfill working faces, tanneries, intensive farming of animals and wastewater treatment plants.
The products available can be classified as follows.

- Masking agents are mixtures of aromatic oils that cover up an objectionable odour with a more desirable one.
- Chemical counteractants are mixtures of aromatic oils that cancel or neutralise odour and reduce the intensity.
- Digestive deodorants contain bacteria or enzymes that eliminate odour through biochemical digestive processes.
- Chemical scavengers are chemicals that can be added to materials to react with the potentially odorous substances. Use includes removal of sulphur from spills of crude oil.

Design considerations
There are few situations where the addition of another chemical to the air rather than dealing with the problem at source would represent best environmental option from a regulatory viewpoint. Whilst each case should be examined on its merits and according to the process guidance, the following indicates situations where the use of modifying agents might be appropriate.

- As a temporary measure whilst process or plant modifications are made and/or an odour management system is being put into place.

- For dealing with a short term problem, or perhaps to provide additional abatement for infrequent odour events (e.g. to cover short-term seasonal variation).

- Where the agent is used in a duct or scrubber such that it is contained and there is no carry over of the agent to the atmosphere occurs where it could undergo subsequent dispersion and have an impact upon receptors.

Common systems and uses
Masking agents are generally only suitable for assisting in the control of odours from large area sources, such as landfills. Even in these cases they should not be relied upon for odour control, but should act as a 'last line of defence' after stringent management practices and adequate buffer distances. Agents are often more suited to process failure or abnormal emissions than routine control. In these cases they should be seen as a temporary rather than a permanent solution.

Digestive deodorants are usually added to wastewater treatment systems to promote biological activity and to prevent the release of the odorous compounds into air.

Advantages	Disadvantages	Common problems/lessons
Modest capital outlay. Atomiser units are portable, can be rapidly deployed. Highly visible means of being seen to take action over a problem.	The application of odour counteractants can be problematic because an emission may vary in concentration or nature with time. These variables make it difficult to ensure that unpleasant odours are "blotted out" at all emission levels. The odour of the modifying agent can itself become a source of annoyance. Factors such as differing diffusion characteristics of the modifier and the odour itself may cause the odour to separate from the modifying agent at a distance, thus producing two distinctly different odours at different points. The ongoing cost of the modifying agent can be very expensive and maintenance costs can be high as fine spray nozzles can be prone to blockage. Some of the components such as surfactants can make surfaces slippery. Careful consideration needs to be given to the selection of the agent as it may in itself be harmful to human health or the environment.	Care needs to be taken with the use of masking agents because the combination of chemicals may result in an odour that is even more objectionable or offensive. Application should not be considered where the odorous emission carries a risk to health or the odour itself serves as a safety warning. The operator can sometimes feel that this is a 'simple fix' to an odour problem on site and so either not identify the root cause of the problem or dismiss other alternatives.

Ducted and point source emissions

Where odorous streams cannot be eliminated through substance substitution, process modification and other measures, they should be captured and controlled within the process system to avoid contaminating the much larger volumes of "ventilation air" within buildings. The overall cost of treating an odorous gas stream is determined to a large extent by the volume of air involved. Good containment of intensely odorous process gas and effective treatment prior to discharge or to mixing with general ventilation air can remove the need for treatment of a much larger volume.

General principles for minimising odour releases associated with ducted or point-source emissions include:

- Use of negative pressure systems to prevent odorous gas leaking out. If a process building is put under negative pressure, consideration must first be given to the health and safety of operators within the building.

- Testing of buildings, tanks and storage areas using smoke generators can provide a quick and easy means of identifying holes and leaks from which odour may escape. Leak testing in this way often provides a very positive initial step in a programme to identifying odour sources, and can all help in creating a more efficient negative pressure system.

- Ensure that hot emissions take place from the minimum practicable number of stacks in order to obtain maximum advantage from thermal buoyancy. This is particularly important when new plants are being designed or when changes are being made to existing processes. If practicable a multi-flue stack should be used

- Ensure that stack heights are sufficient to ensure adequate dispersion under normal conditions.

- Ducts should be designed and the velocity inside them maintained such that the accumulation of material inside them is minimised. In general, pipework should be designed to allow a flow velocity of greater than 5 metres per second (m/s) and may need to be greater than 10m/s if the gas stream has a heavy particulate loading. The flow velocity should be kept as constant as possible throughout the system. The angle at which branches enter the main duct should ideally be about 30^0 and should not exceed 45^0.

- All flues and ductwork should be cleaned to remove any accumulation of materials, as part of the routine maintenance programme. This will require suitable access and drainage points to be incorporated into the system. However the number of access points should be carefully balanced against the increased potential for leakage as the number of openings increases.

- Exhaust gases discharged through a stack should achieve an exit velocity greater than 15m/s during normal operating conditions to achieve adequate dispersion.

- Stacks should not be fitted with any restriction at the final opening such as a plate, cap or cowl, with the exception of a cone which may be necessary to increase the exit velocity of the emissions.

- Emissions with a high water vapour content should be free from droplet fallout. This can be minimised by maintaining the linear flow rate below 9m/s.

The selection of abatement method used is dependent on a number of factors including the properties of the gas to be treated, the physical constraints of the technology, and the standard of the final emission. Draft Guidance Note H4 highlights the following points to consider when selecting odour abatement systems.

Particulates and aerosols
Some processes are very dusty with a significant proportion of odour being associated with the dust, for example some pharmaceutical processes, poultry farms and animal feed compounders. It may be possible to reduce odour significantly by removing the dust or droplets from the exhaust by filtration or mist eliminators. Preliminary particulate control will be required upstream of some forms of abatement equipment, for example packed bed scrubbers will need protection. It may be possible for the collected particulate matter to be recycled, particularly if it has some value.

Concentration and volume of pollutants
The perceived strength of an odour is not necessarily associated with high chemical concentrations. However, generally:

- where high odour/pollutant concentration is associated with small air volumes, incineration may be the only effective odour control option, although an assessment of volume and loading may show adsorption on carbon units to be worth considering;
- multi-stage scrubbing is often more cost effective for larger volumes of highly polluted air;
- medium and low odour/pollutant concentrations are liable to be associated with larger air flows, such as building ventilation systems. They are likely to require abatement by techniques with lower operating costs such as biofiltration.

Temperature
The temperature of the gases to be treated will affect the abatement options which are available or may dictate the need to fit additional pre-conditioning units, such as a gas cooler or condenser. For example, biofilters and carbon adsorbers are unlikely to be effective if the gas temperature is in excess of 35°C and 40°C respectively. Conversely, high exhaust temperatures may reduce running costs if incineration was an option. An additional factor affecting odour abatement is the effect of the temperature on the material of construction. Plastic is frequently used because of its anti-corrosion properties and relatively low cost, however it can be susceptible to thermal damage.

Moisture content
The moisture content of the exhaust gas will also affect the choice of abatement technique. High moisture content is likely to reduce the cost effectiveness of adsorbers due to the preferential take up of water vapour. High moisture content is slightly beneficial for biofilters because it reduces the amount of irrigation the bed requires and it has no detrimental effect on scrubber performance, but it will adversely affect the cost of incineration as an option.

Chemical composition
The chemical composition of an odorous gas stream can affect the suitability of various abatement options in several ways. For example:

- organic compounds may not be suitable for abatement by a water based scrubber but may provide a significant fuel fraction for an incinerator;
- incineration of a gas stream with a high sulphur loading would lead to the formation and release of acidic oxides, unless the incinerator had been designed to withstand and remove these prior to release;
- acidic and basic gases are readily removed in chemical scrubbing by use of a neutralising chemical - for acid gases this would be an alkali;
- easily soluble organic compounds are most suited to bioscrubbing or biofiltration, whereas aromatic compounds and those containing halogens are more difficult to oxidise by this method.

Disposal of waste products
When deciding upon the choice of odour abatement equipment, safe (and legal) disposal routes for secondary wastes, such as scrubber liquor and sludges and saturated carbon, will need to be considered as part of the overall environmental impact, as well as the additional cost.

Other considerations in relation to the equipment include:

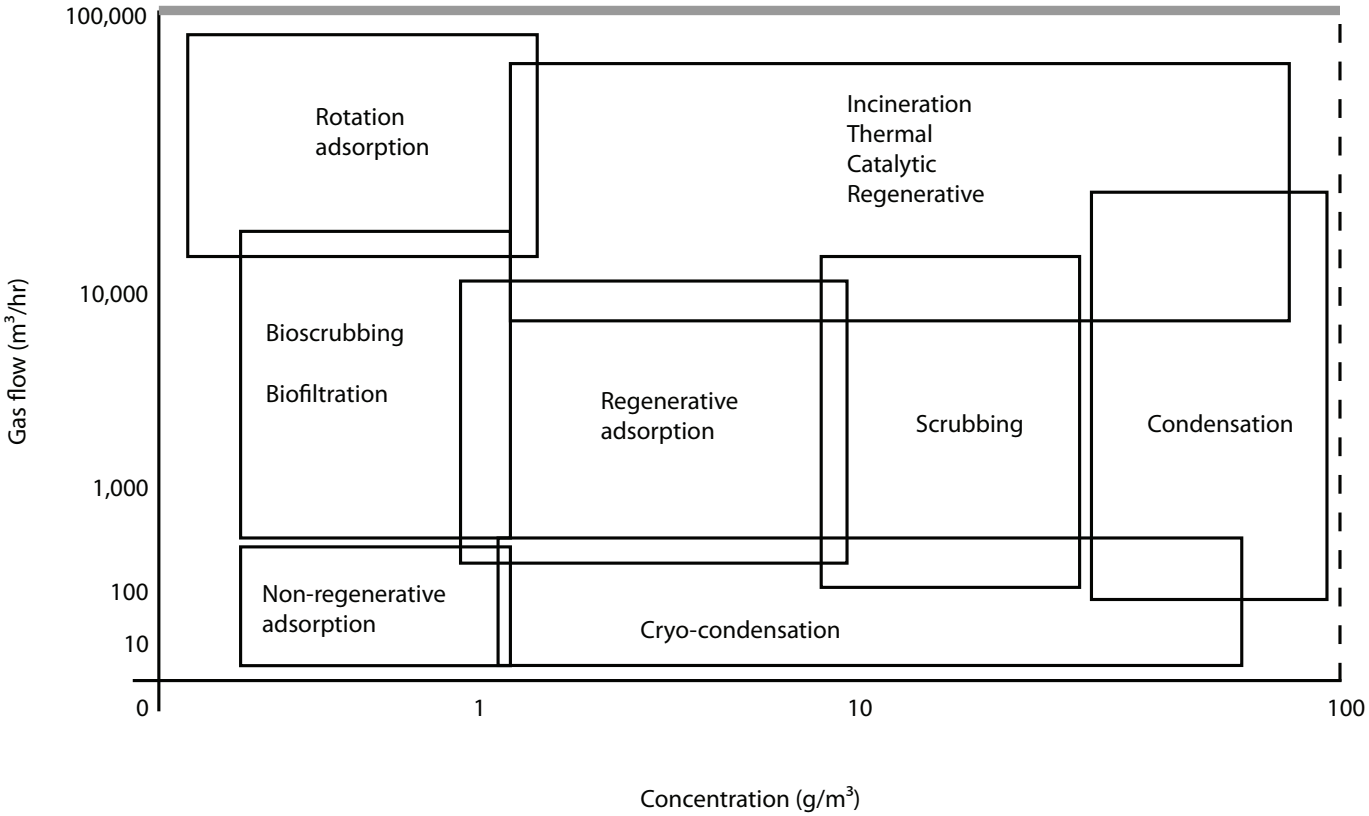
- physical size - available space may be at a premium;
- energy use and noise output;
- safety considerations.;
- reliability and maintenance requirements including down time, start-up and shut-down requirements;
- seasonal fluctuation – external biofilters for example will be subject to lower ambient temperatures during winter months but may be at risk of drying out during dry months – both of which can adversely affect performance;
- complexity and need for training and skilled staff;
- consistency of concentration and composition.

Discharging waste gases to atmosphere
The standard and quality of the final emission required to be achieved will be influenced by local topography, prevalent weather conditions and height of discharge which all affect the behaviour and dispersion of the treated emission. See the section above on dispersion/dilution for more information.

Table A4.1: Summary of generalised criterion for selecting odour abatement techniques

Treatment	Flow rate		Temperature		Relative humidity		Particles		VOC concentration		Sulphide based odorants		Nitrogen based odorants	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Condensation	✓	✗	✗	✓	✗	✓	✓	✗	✓	✓	✓	✓	✓	✓
ESP	✓	✓	✓	✓	✓	✓✓	✓	✓	✓	✓	✓	✓	✓	✓
Absorption – water	✓	✓	✓	✗	✓	✓	✓	✓	✓	✗	✓	✗	✓	✗
Absorption – chemical	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Adsorption	✓	✗	✓	✗	✓	✗	✓	✗	✓	✓	✓	✓	✓	✓
Biological	✓	✓	✓	✗	✓	✗	✓	✗	✓	✗	✓	✗	✓	✗
Thermal oxidation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Catalytic oxidation	✓	✗	✓	✓	✓	✗	✓	✗	✗	✓	✓	✓	✓	✓

Summary of generalised criterion for selecting VOC abatement techniques



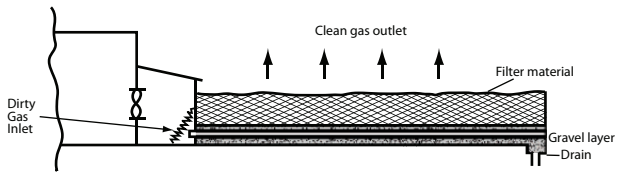
Biological treatment

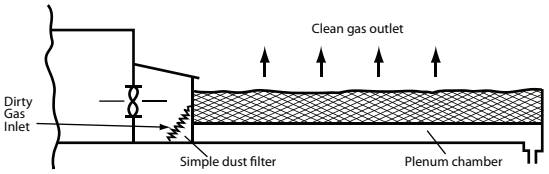
Biological treatment relies on the organic odorous compounds being metabolised and consequently degraded by naturally-occurring micro-organisms into non-odorous products. All systems are therefore required to be able to support a population of micro-organisms (a damp environment for microbial activity, oxygen and provide trace nutrients) and to enable sufficient contact between the population and foul gas. Once established the microbial population will undergo a degree of self-selection to adapt to the defined odorous gas stream. Biological treatment systems fall into two main categories:

Bio-filtration employs a bed comprising a media substrate to support the naturally-occurring micro-organisms and a delivery system to allow even distribution of the odorous gas at the required conditions. Once passed through the bed, the treated air stream is discharged from the surface of the filter although sometimes an enclosure is fitted and the stream is discharged via a stack. The bottom of the bed is kept moist by passing the incoming air through a humidifier where required and at the top of the bed through the use of an irrigation system. Bio-filtration can be further split based on media type and the resultant requirements in operating parameters.

Soil: the filter consists of a layer of soil overlying a distribution system consisting of a network perforated pipes within a gravel bed.

Non soil: typical media includes woodchip, peat (plus a component to avoid compaction), composted domestic waste, calcified seaweed etc. The distribution system can consist of a network of perforated pipes or a plenum and distribution chamber where the media is supported at height. A residence time of between 45 and 60 seconds is required and where maintained correctly a bed can last between 3 to 5 years.





Bio-reactors/scrubbers apply the same principles as biofilters however the odorous gas is passed up a packed tower through a counter current flow containing a population of microbes. The packing provides support for the microbes as they adhere to it (microbial film) allowing contact with the passing gas. Packing can be organic as the non soil filters above or be of an inorganic nature.

Design considerations

Process conditions and fluctuations (such as odour concentration, nutrient loading, temperature, moisture content, pH, chemical constituents/potential for poisoning), media type.

Common systems and uses

Biological treatment systems are ideally suited to processes which produce large volumes of foul air with low to medium odour concentrations and are often employed as a final "polishing stage". Industries where the technology has been applied include rendering plants, intensive livestock installations, maggot farms, animal foodstuff producers, perfumeries, fine chemical and food/drink processes and waste water treatment works.

Advantages	Disadvantages	Common problems/lessons (potential actions that can be taken in (brackets))
Non soil filters can be up to 95% efficient while Soil filters and bio-reactors can be more than 99% efficient. Minimal secondary pollution (wastes generated) Relatively inexpensive to install and maintain compared to other abatement options Bioreactors have additional benefits in that they have a small footprint compared to biofilters and the replacement of the support medium is not required.	Processes can not be treated where there are high levels or variability in odour concentrations (slow adaptation of micro-organism population) or interruptions in process flow and batch processing. In order to ensure high removal efficiency, inlet conditions (temperature, pH and humidity) must be maintained within narrow bands and regular maintenance is required. Large land areas required for biofilters, also larger biofilters tend to have problems with even distribution and maintenance. Bio-reactors have higher running costs than soil biofilters which in turn have higher running costs than other biofilters. Additional nutrients may be required to support the microbial population. Need for contingency plans in case the microbial population is destroyed/poisoned and when media is changed. Monitoring can be difficult unless covered (can measure at the outlet). The removal efficiency is limited by ambient conditions. Sloughing of the biomass can occur - microbes break away from the inert support.	Moisture/drying: It is essential to ensure that the media remains wetted otherwise this can cause cracking (see below) and reduces the micro-organisms population and available interface for odour removal. Once the bed has dried out is difficult to re-wet. Over wetting should be avoided because it is important to maintain aerobic conditions. Frost can cause similar problems. (You could cover system) (You could recycle effluent water however need to consider pH (acidification), nutrient loading and natural airborne compounds H&S) Particles/fats: it has been known for the nozzles within the humidifiers and irrigation systems as well the foul air distribution system to become blocked. Nozzles and pipework should be periodically checked for blockage and pre-treatment considered. Blockage can also be caused by flooding. (results in over watering/poor drainage) Bed structure: inspections should be carried out to ensure that an even distribution of foul gas through the bed is being achieved. Cracks and holes in the bed can form as well areas of compaction (you could consider turning bed) leading to preferential paths reducing residence time and allowing gas to escape untreated. (You can look for dry/cold patches/steam rising). Frost damage Contingency: biofilters are often used as contingency where primary odour abatement has failed. The biofilter is unlikely to abate the odour emissions in this case and is likely to be taken out of action due to high odour/temperature.

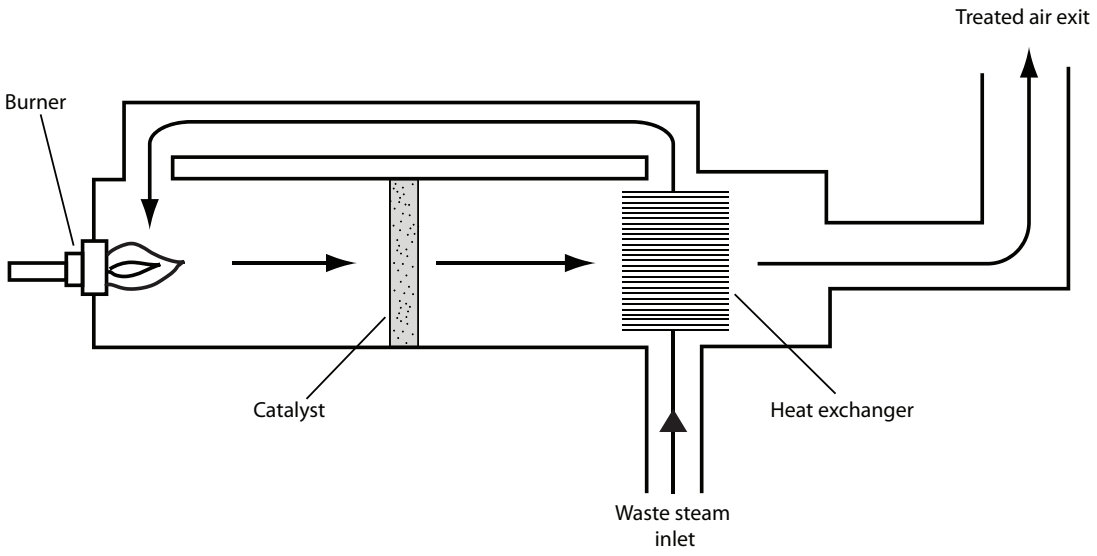
Incineration

The process of incineration or thermal oxidation can be used for the effective destruction of odorous compounds and may be described as the process whereby waste (odorous gas) is heated with either air or oxygen at high temperature in a combustion appliance. If the combustion is complete and the wastes (odorous gas) are organic compounds, then the products of combustion will be carbon dioxide, water and oxides of nitrogen. Complete combustion is dependent upon uniform mixing of fuel, the odorous gas stream and combustion air. The configuration of burner, mixer and combustion chamber are important to effective mixing.

Burner	Fuel is burnt with clean (or contaminated) air to produce a flame at approximately 1,500 °C.
Mixer	The remainder of the contaminated air is mixed with hot gas from the flame to bring the mixture to a uniform temperature.
Combustion chamber	The gases are held at this temperature until oxidation has been completed (typically 0.5-1 seconds, though this is dependent on the species to be destroyed, the design of the plant and the temperature employed). It is the combination of temperature and residence time that ensures adequate destruction with various combinations available.

Thermal incineration uses the process as described above and typically employs temperatures of between 650 to 800°C to ensure the effective destruction (dependant on residence time) of odorous gas in a well-designed incinerator. Rapid oxidation of odours occurs if the gas temperature is typically in the range of 750-800°C. Existing kilns, furnaces and boilers can sometimes be used to incinerate odours where the temperatures and residence times lie within the appropriate range.

Catalytic incineration uses the process as described above however the oxidation reaction takes place on the surface of the catalyst where odorous contaminants and oxygen diffuse from the air stream are adsorbed onto the catalyst surface rather than in free air. Catalytic incineration therefore requires lower temperature, (typically 350 to 400°C) and lower residence time. Once oxidation takes place the products are desorbed back into the gas stream. Typical catalyst materials include platinum, palladium, rhodium, copper chromate and oxides of copper, chromium, manganese, nickel and cobalt supported on a base material. Catalytic incineration is an appropriate odour abatement technique when odour concentration is high and there is little or no particulate matter in the process stream.



Design considerations

Design considerations include:

- odour concentration,
- nature of the odorous gas stream and required pre treatment (effects of entrained dust on catalyst and equipment/potential for catalyst poisoning etc);
- capital cost;
- operating cost;
- fuel availability;
- available space;
- choice of catalyst;
- properties of the catalyst;
- combustion products;
- further abatement requirements (treatment of acid gases etc);
- legislative requirements.

Common systems and uses

Almost universal application to odour control is possible because all organic odours can be oxidised at high temperature, however due to cost considerations incineration treatment systems are ideally suited to processes which produce low volumes of foul air with medium to high odour concentrations. Industries where the technology has been applied include:

- animal rendering plant;
- rape seed oil extraction;
- blood drying plant;
- barley roasting;
- plastic processing;
- coffee roasting;
- paint spraying;
- synthetic rubber manufacture;
- oil refining.

Advantages	Disadvantages	Common problems/lessons
Non-specific: can be applied to almost all odour control scenarios as all organic odorants can be oxidised at high temperature. Can handle very high inlet odour levels. Very high odour removal efficiencies. Primary heat recovery is possible. The incinerator exhaust gas is used to pre-heat the incoming gas stream, reducing requirements to heat gases in the incinerator. This is achieved directly (recuperative) or where the incinerator exhaust gas is passed through several ceramic bed heat exchangers which in turn pre-heat the incoming gas stream. Oxidation of the off-gas also continues in the ceramic beds. In regenerative systems higher heat recovery is achieved however the potential exists for the incoming gas to contaminate the exhaust gasses and so the ceramic beds alternate between heating, cooling and purging. Secondary heat recovery is achieved through the generation of steam and hot water. Existing boilers can sometimes be adapted for use as thermal incinerators. Catalytic incineration achieves effective destruction at lower operating temperatures and so requires less energy. Units also tend to be smaller.	Capital and operating costs are high. Maintenance of smooth operation (burners) required. The volume of air requiring treatment can be a limiting factor in terms of cost, as can the requirement for high temperatures (eg for oxidising ammonia). Further abatement: need to cope with SO2 or HCl formed from compounds containing S or Cl. Acid gases create further odour issues. Pre-treatment: • condense water vapour from a wet gas - this reduces fuel requirements and minimises corrosion problems. • remove solid and liquid contaminants - to minimise risk of fouling, corrosion, attrition and catalyst poisoning fouling (adsorption active sites). Blinding (dust). Continuous monitoring for carbon dioxide and/or oxygen, carbon monoxide and oxides of nitrogen in the effluent gas stream is generally required. There is also a requirement that temperature is measured as a means of monitoring combustion conditions. Sampling and analysis techniques suitable for high temperatures are required. Spent catalyst waste stream requires disposal.	There are several potential difficulties: • not all boilers or kilns work for 24hrs/day and hence they may not be able to treat a continuous odour emission all the time. • the destruction of odorous compounds requires steady conditions of temperature and flow, whereas steam-raising boilers or furnaces may be subject to fluctuation as the loading demands change. • the flow rate or temperature profile may not be suitable without major changes. • materials of construction may not be able to withstand the corrosive effects of nitrogen or sulphur compounds. • Computation Fluid Dynamic study (CFD) should be carried out to ensure that the temperature and flow characteristics are adequate to ensure odour destruction and that there are no cool or dead spots within the boiler/incinerator; • physical methods for demonstrating residence time exist and should be employed to ensure adequate destruction is achieved; • breakdowns can often require specialised parts/repair and may take some time to rectify. Consideration should therefore be given to the establishment of a maintenance contract to ensure speedy repair, back up systems for odour control and contingency plans to ensure odour is minimised in the event of a breakdown.

Adsorption

The process of adsorption is where one substance adheres to the surface of another substance. In this instance there is a mass transfer of gas molecules (odorant) from the bulk of gas through diffusion until the molecules are finally adsorbed onto an internal surface (adsorbent). All adsorbent systems fall into two main categories;

Fixed beds (gas passed through a stationary bed of adsorbent material) are simple, economical and require minimal solids handling, however for much of its operational life, a large proportion of the adsorbent bed is saturated and the larger the flow of gas to be treated the larger the fixed bed required.

Fluidised beds (gas passed through a suspension of adsorbent) and continuous moving beds (adsorbent falls by gravity through the rising gas) have multiple stages and are continuous in operation overcoming some of the disadvantages of a fixed bed system. However the continuous handling and transport of solids is required, which is expensive, can lead to mechanical problems and promotes attrition. Systems must be large to be economical.

Design considerations

Design considerations include:

- adsorbent selection;
- adsorptive capacity;
- process conditions – temperature, moisture content, chemical constituents (preferential adherence, block adherence).

Common systems and uses

The most common adsorbent in use is carbon, normally as activated carbon, although others are available such as silica gels, alumina and zeolites. Some types of activated carbon may be doped with other chemicals to improve selectivity.

Adsorbents can be used for a range of odorous materials but care should be taken that the capacity of the adsorbent is not exceeded through excessive flows or high odorant loadings. This may result in the adsorbent requiring be regenerated or replaced at frequent intervals. Activated carbon can be readily regenerated several times.

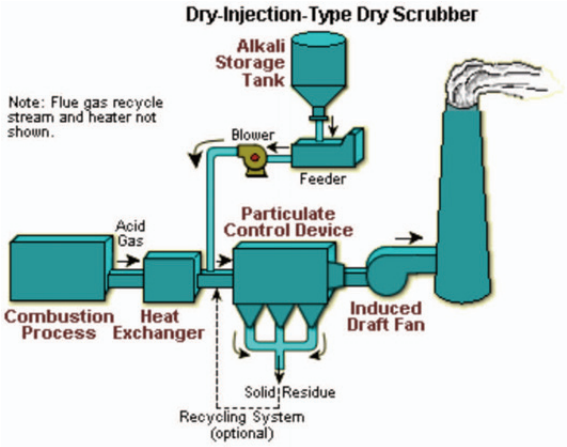
Advantages	Disadvantages	Common problems/lessons
Depending on the chemical species involved, efficiency can be in excess of 99% for a new adsorbent. Depleted adsorbent can often be regenerated and reused (larger applications, may not be cost effective on smaller units). Smaller applications can make use of easily replaceable, cartridge-type units. Relatively low cost compared to some other systems. High temperature and humidity may cause odour breakthrough. Temperatures less than 40°C required for activated carbon systems.	High particulate content may cause clogging of bed. High concentrations of odorants will cause rapid saturation. Efficiency will deteriorate over a period as the bed becomes saturated. Disposal required for waste adsorbent which cannot be regenerated (for whatever reason). Pollutants may flash off unless contained. Regeneration will produce a gas stream which will require abatement. Ancillary equipment may be needed to precondition the gas stream before the carbon bed/filter: this can add considerably to the cost.	Breakthrough: predicted and actual. Often the first sign is odour release. Many systems use two adsorption units in series and undertake monitoring between beds to alert of breakthrough. Vapours (odours) will travel the path of least resistance. Care has to be taken with the system design to ensure that the backpressure exerted by the bed does not mean that odours never reach the adsorbent material.

Dry scrubbing

A dry or semi-dry scrubbing system, unlike the wet scrubber, does not saturate the flue gas stream that is being treated with moisture. In some cases no moisture is added, while in other designs only the amount of moisture that can be evaporated in the flue gas without condensing is added.

There are a number of dry type scrubbing system designs. However, all consist of two main sections or devices: a device to introduce the acid gas sorbent material into the gas stream and a particulate matter control device to remove reaction products, excess sorbent material and any particulate matter already in the flue gas.

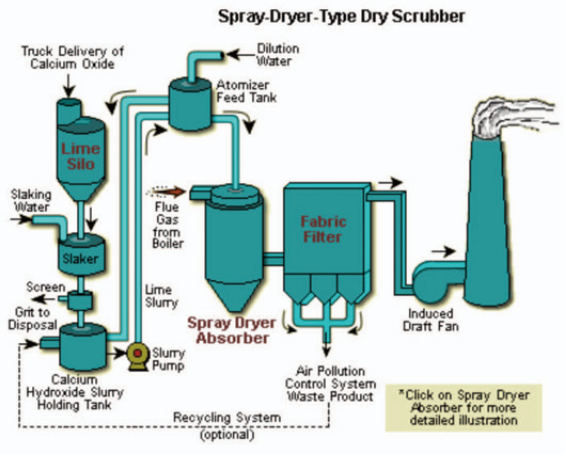
Dry scrubbing systems can be categorized as dry sorbent injectors (DSIs) or as spray dryer absorbers (SDAs). Spray dryer absorbers are also called semi-dry scrubbers or spray dryers.



Dry sorbent injection involves the addition of an alkaline material (usually hydrated lime or soda ash) into the gas stream to react with the acid gases. The sorbent can be injected directly into several different locations: the combustion process, the flue gas duct (ahead of the particulate control device), or an open reaction chamber (if one exists). The acid gases react with the alkaline sorbents to form solid salts which are removed in the particulate control device.

REF: US EPA Website, Education and Outreach, Basic Concepts in Environmental Sciences

In spray dryer absorbers, the flue gases are introduced into an absorbing tower (dryer) where the gases are contacted with a finely atomized alkaline slurry. Acid gases are absorbed by the slurry mixture and react to form solid salts which are removed by the particulate control device. The heat of the flue gas is used to evaporate all the water droplets, leaving a non-saturated flue gas to exit the absorber tower. Spray dryers are capable of achieving high (80+%) acid gas removal efficiencies.



REF: US EPA Website, Education and Outreach, Basic Concepts in Environmental Sciences

Design considerations

The active ingredient of the dry scrubber is specifically designed for chemical reaction with the reactive species in the process gas. The abatement power of a chemisorbing material is described as capacity and is measured in units of moles of gas per volume of dry material.

Common systems and uses

Dry scrubbing systems are used to remove acid gases (such as SO2 and HCl) primarily from combustion sources. Dry sorbent injection has been used on medical waste incinerators and a few municipal waste combustors while spray dryer absorbers have been used on industrial and utility boilers and municipal waste combustors.

Advantages	Disadvantages	Common problems/lessons
Dry scrubbers do not have a stack steam plume or wastewater handling/disposal requirements. Spray-dryer-type absorption systems have efficiencies that are similar to those for wet-scrubber-type absorption systems. These generate a waste stream that is dry and, therefore, easier to handle than the sludge generated in a wet scrubber. A dry-injection-type dry scrubber can be used on smaller systems as opposed to using the larger, more complicated spray-dryer-type dry scrubber.	Dry sorbent injection simple systems can achieve only limited acid gas (SO2 and HCl) removal efficiencies. Higher collection efficiencies can be achieved by increasing the flue gas humidity (ie cooling using water spray). The equipment used to atomize the alkaline slurry is complicated and can require considerably more maintenance than wet scrubber systems. Spray-dryer-type absorption systems operate at higher gas temperatures than wet scrubbers and are less effective for the removal of other pollutants in the gas stream, such as condensable particulate matter. The dry injection system is slightly less efficient and requires more alkali per unit of sulphur dioxide (or other acid gas) collected than the spray dryer type.	A solid waste stream is introduced. The waste disposal requirements and costs are higher for dry injection systems than spray dryer systems.

Dry chemical scrubbing

The process of dry chemical scrubbing is where one substance chemically reacts with another. In this instance gas molecules (odorant) react with chemisorptive materials to form non volatile, non-hazardous substances. Dry scrubbers differ from traditional catalysts in that dry scrubbers are, for the most part, unable to be regenerated and reused. Once consumed, materials cannot desorb any hazardous gases that were chemisorbed.

Dry chemical scrubbing is effectively a sub-set of adsorption; non-regenerative adsorption.

Dry chemical scrubbers are a relatively recent addition to the odour abatement market and typically consist of an oxidising chamber and a polishing stage.

The oxidising chamber contains a support material which is impregnated with oxidising material (eg chlorine dioxide, potassium permanganate etc.). The odorous gas passes up through the oxidising chamber where it is adsorbed and then oxidised to non-odorous by-products.

The polishing stage comprises activated carbon which is used to remove any un-oxidised odorous compounds.

Design considerations

The active ingredient of the dry scrubber is specifically designed for chemical reaction with the reactive species in the process gas. The abatement power of a chemisorbing material is described as capacity and is measured in units of moles of gas per volume of dry material.

Common systems and uses

Dry chemical scrubbers are ideal for extremely low flow, relatively high concentration odorous gas streams. They can be purchased as stand alone systems so that one unit can be installed next to one source – this is advantageous because there is no need for a complicated ducting system and therefore the overall price may be cheaper.

Advantages	Disadvantages	Common problems/lessons
For example solid phase impregnated with chlorine dioxide or potassium permanganate: • relatively low cost; • low maintenance; • small plant footprint; • complex ducting arrangements are not required.	• emission of oxidised products, eg chlorine; • washout of oxidising products possible eg potassium permanganate, potassium iodide; • oxidising media lifespan, and therefore cost; • specialist labour required for media replacement; • potential for low odour removal effectiveness because of high residual chemical odour; • not particularly suitable for high gas flowrates.	Good for small scale operations using disposable cartridges but these can be expensive if used on a large scale.

Absorption wet gas scrubbing

The process of absorption is where one substance is taken up by another substance. In this instance gas molecules (odorant) are taken up by a liquid. There is a mass transfer of a gaseous pollutant from the air into a contacting liquid, such as water. The liquid must be able to serve as a solvent for the pollutant or to capture it by means of a chemical reaction. There are five generic types of absorber.

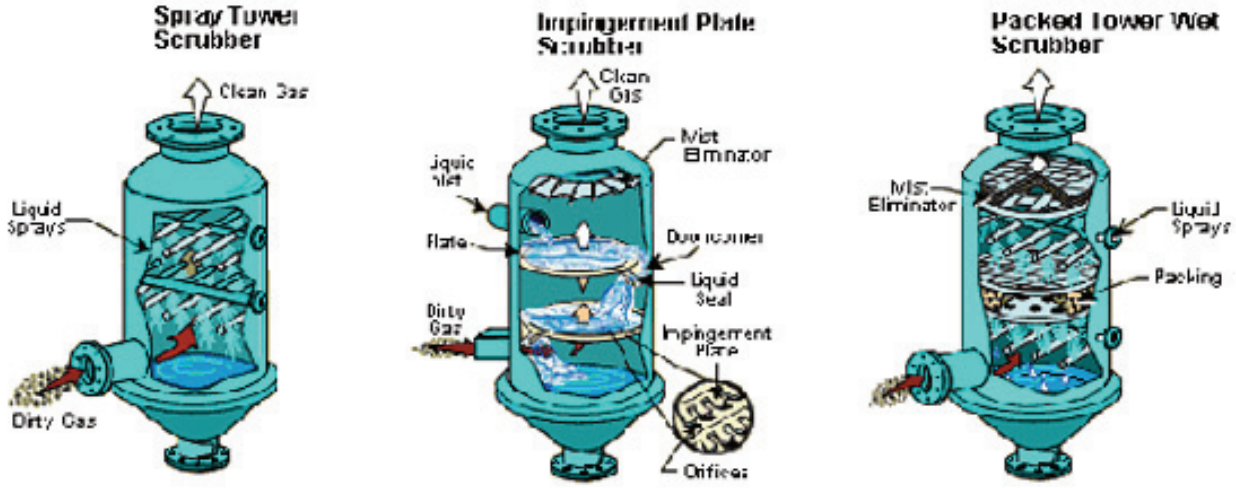
Spray tower (liquid enters top of tower as dirty gas stream passes up tower) is the simplest type of wet scrubber and will tolerate dusty gas streams but are not as effective for trace gas removal.

Plate absorbers (liquid enters top of tower with horizontal perforated trays as dirty gas stream passes up tower) can operate at high liquid flow rates and are able to tolerate fluctuations in gas flow and temperature however are not suitable for use with slurries or foaming liquids.

Packed bed absorbers (liquid is distributed continuously over a packing material as the dirty gas stream flows through the packed bed) are generally the preferred type of gas absorber for treating odorous gas streams due to their high efficiencies. However they are not suitable for gases with a high concentration of particles and can be expensive compared to other scrubbers.

Moving bed absorbers (liquid and dirty gas mix in zones of mobile packing) are suitable for simultaneous removal of trace gases and particulates.

Fibrous packing absorbers (liquid is sprayed continuously or intermittently over fibrous packing in dirty gas inlet and outlet) are relatively inexpensive and can treat up to 50% more than packed tower.



REF: US EPA Website, Education and Outreach, Basic Concepts in Environmental Sciences

In addition to the five generic absorber types, where a number of odorous compounds are present in a gas stream which requires different reagents, enhanced catalytic absorption in a two or three stage scrubber may be needed.

Design considerations

The efficiency of mass transfer depends on several factors:

- solubility of odorous component in the liquid phase;
- gas–liquid contact time;
- contact area.

Common systems and uses

Absorption (scrubbing)
Spray towers have been successfully used by various sectors of the chemical industry for absorbing acid gases and odours, for ammonia hydrolysis and for particle abatement.

Plate absorbers are effective for trace gas removal and particle collection. The technology has been successfully used in the chemical industry and industrial heating plant for the absorption of acids (in water), SO2 (using sodium sulphite) and odours. They have also been used to abate odours from animal feed mills.

Packed tower absorbers, with the appropriate reagents, have been successfully used for absorbing acid gases and odours from boiler flue gases, chemical, food, metallurgical and petroleum processes. Applicability is potentially wide with appropriate choice of reagents.

Moving bed absorbers have been successfully used for trace gas removal (sulphur dioxide, hydrogen fluoride and odours) and particle collection in the metallurgical, chemical and food industries, power generation, sintering, mineral processing and waste industries.

Fibrous packing absorbers have used by the chemical, metallurgical and electronics industry to remove acidic components and organic/inorganic compounds from contaminated air streams.

Catalytic scrubbing
Catalytic scrubbing was developed in order to combine several stages into a single absorption unit.

Advantages	Disadvantages	Common problems/lessons
Absorption (scrubbing): Can handle large volumes of air Efficiency >90% (Ƃ2 stage scrubber) – water. Efficiency >99% - chemical. Automatic dosing can allow for rapid reaction to presence of peaks in concentration, provided they are not too Acute. Catalytic scrubbing: Acid scrubbing may not be required. Total odour control in a single packed tower is possible. High odour removal efficiency for organic odorants.	Absorption (scrubbing): Concentration of contaminants may require pre-dilution with clean air. Chemical reagents needed unless dealing with water soluble compounds. Fairly specific; reagents must be matched to nature of contaminants. A multi-stage scrubber may be needed to deal with a stream containing, for example, acidic and basic components. This increases the cost and complexity. Scaling and corrosion can be a problem, particularly when chemical reagents are used. Salt formation (often in the form of a gel) can block pumps. Salts may also block packed scrubber systems with the subsequent formation of preferential routes for liquor through the packing, with adverse results. Maintenance requirements may consequently be quite high. Use of chemicals can be high – careful process monitoring and control is required. Particulates can cause blockages in packed towers. A mist eliminator may be required to prevent carry over of droplets. Catalytic scrubbing: Potential for catalyst fouling. Does not remove insoluble organic odours. At high concentrations of basic odours, acid scrubbers may be more cost effective.	Saturation of contacting liquid can occur. Fibrous packed columns are prone to blockage by particulates and growth of biomass. Oxidants can sometimes lead to the formation of odorous compounds in the scrubber which can create a secondary source of odour. The effluent must be considered as part of the total environmental impact. Spray nozzles may block from particulates in spray towers. Residues and precipitates can build up and may require flushing. Packed columns are more difficult to flush than spray towers.

Open systems

It is accepted that for certain activities it is not always possible to contain odorous substances due to the nature of the activity being undertaken. Such activities include landfill, composting (windrow), land spreading and coating of large vessels/objects etc. In such instances it is important that the principles described in the management and design section of this document are applied in the first instance, however the following techniques can be applied.

Landfill

Potential odour sources at landfill sites include landfill gas, leachate and newly deposited material. Odour from leachate and (under normal circumstances) landfill gas can be collected, contained and treated in a manner detailed above. Where little gas is produced from a landfill there may be insufficient pressure to allow for effective/efficient collection and treatment.

Guidance on appropriate techniques for landfills that are producing gas is available on our website at: www.sepa.org.uk/waste/waste_regulation/landfill.aspx

Odour from newly deposited material should be controlled through a mixture of waste acceptance criteria and the covering of material. Careful consideration should be given to the cover material type (soils, sands, clays, paper pulp, sheeting etc), depth and frequency of application of cover material (not washed away during rain etc). Further information on cover can be found in Waste Management Paper 26B – Landfill Construction and Operational Practice, Section 9, Paragraph 9.70 to 9.81.

Composting

Odour from in vessel composters can be contained, collected and treated in a manner detailed above . Open composting (ie in windrows) may not be feasible depending on the land take and costs involved. Careful consideration of the location and the management and maintenance of the windrows is therefore necessary. Management considerations should include:

- material types to be composted;
- suitability of composting method to be employed (if odorous consider in vessel type composter);
- careful balancing of carbon/nitrogen content etc.

Maintenance issues include:

- avoidance of conditions leading to anaerobic conditions within the windrow;
- frequency of turning;
- assessment of meteorological conditions when turning (wind direction) etc.

In some circumstances the techniques mentioned above may not be sufficient and consideration to local or full enclosure of windrows should be considered. Local enclosure could involve using a cover material such as fully matured compost or peat/soil to act as an odour barrier or the use of propriety membrane coverings. Several systems are available on the market. Additionally there are systems available that actively aerate the windrow by drawing air through the windrow through a vacuum system. This keeps the windrow under a slight negative pressure reducing the likelihood of odorous emissions. Full enclosure would involve the composting to be undertaken in a specifically designed building so that emissions can be collected and ducted to appropriate abatement and discharge systems (see above re containment and capture). Fully enclosed systems can also have specific design features to allow automated mixing/turning of windrows etc.

Land spreading

Spreading of certain odorous wastes can be carried out under a waste management exemption. It should be noted that if the spreading activity does not meet the 'relevant objectives' – one of which is not to cause a nuisance – the exemption will fall. When spreading is to be undertaken consideration should be given to meteorological conditions (wind direction), the location of the area to be spread (proximity to domestic dwellings, footpaths, picnic areas etc) and the time of spreading (time of day, weekends, public holidays etc). Further guidance can be found in the PEPFAA Good Code of Practice.

Coating

Due to the nature of some coating activities (painting of large vessels such as boats, or the refurbishment and painting of large sections of pipe and steel work) it makes it difficult for any odours generated to be contained, collected and treated. There are examples of certain activities, such as those fully or partially enclosed (small 'tent' which extends over the area being worked at the time): in such instances the methods detailed above should be adhered to. Where it is not possible for this to be done then other methods, usually management, need to be considered.

Consideration should be given to:

- the selection of the coating (paint) material to be used (the higher the solids content and the lower the solvent content the better as generally the odour associated with coating arises from the solvents employed);
- the application method, storage and preparation of paint;
- the cleaning of painting materials once finished should be carried out in a contained area (minimisation of exposure and allows extraction and treatment where necessary);
- the time of spraying (windy conditions can contribute to overspray and so increase the length of time and volume of coating applied, wind direction etc).

Techniques that can be used in an emergency situation

Provision for emergency techniques

In an emergency situation where there is the potential for odour release or if there is a breakdown in the designed odour abatement equipment the primary consideration must be to stop processing.

Emergency techniques should only be considered when it is not possible to stop processing (leaving plant in an inoperable or unsafe state) or when the odour being generated on site is not directly related to the continuing processing activities. It is also incumbent upon the operator to demonstrate why the best option is not simply to cease operation until the designed odour abatement equipment is brought back on line.

Where it is anticipated that odour control techniques may be needed in the event of an emergency then provision can be made within the permit, licence or management plan for its inclusion. This can be in the form of stating the specific technique to be employed, or simply providing for the option of plant being brought on to site with the agreement of SEPA. The former option allows a proper assessment to be made on the acceptability of a specific technique for the site and allows for consideration of local factors.

Where provision is not included within a permit, licence or management plan a variation or modification may be required. This will take time to process thereby preventing the ability to act quickly in an emergency situation. Under Waste Management Licensing it should still be possible to bring equipment on to site and control it through the working plan. Care should be taken to ensure this is the case.

In any case careful consideration should be given to the circumstances in which emergency techniques are allowed to be carried out and for how long.

Technical options available

All of the techniques identified above could be used in an emergency situation. Some, however, can be used more readily than others through the ready availability of mobile, package or skid mounted equipment.

The use of masking and neutralising agents and the use of adsorption systems such as activated carbon systems are the most common techniques available. Although as indicated above masking systems should only be used as a last resort.

The use of such a technique may give short term relief to an odour problem and should be considered while longer more permanent odour prevention and reduction techniques are implemented. A number of vendors are available and these can be found through trade journals or by searching the internet.

Emergency techniques tend to have higher costs associated with them and will require close supervision to ensure that they operate effectively.
