

# Code of Practice on Odour Nuisance from Sewage Treatment Works



Llywodraeth Cynulliad Cymru  
Welsh Assembly Government



**defra**

Department for Environment  
Food and Rural Affairs

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Welsh Assembly Government



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## **Ministerial foreword**

Odour from sewage treatment works can have a detrimental impact on the quality of the local environment for those living close by, yet sewage treatment works are essential for maintaining standards in water quality. That is why Defra and the Welsh Assembly Government have worked with local authorities, water companies, non-departmental public bodies and other stakeholders to produce a *Code of Practice on Odour Nuisance from Sewage Treatment Works*.

The December 2002 *Consultation on Proposals for the Statutory Control of Odour & Other Nuisance From Sewage Treatment Works* showed that there is strong support for the use of the statutory nuisance regime to control odour nuisance from sewage treatment works, along with a Code of Practice to support enforcement and good practice. This consultation was published at a time when the applicability of the statutory nuisance regime to sewage treatment works was in dispute in the courts. However, the High Court ruled in May 2003 that sewage treatment works are “premises” for the purposes of section 79 of the Environmental Protection Act 1990. This ruling, *London Borough of Hounslow v Thames Water Utilities Limited*, confirmed once again that the statutory nuisance regime applies to odour from sewage treatment works.

It is acknowledged that adherence to the Code of Practice may not result in zero odours around a sewage treatment works under every circumstance. The Code will help regulators and operators in a number of ways by:

- Providing guidance to local authorities, operators of sewage treatment works and other interested parties on how the statutory nuisance regime works.
- Providing guidance on good practice measures for managing odour nuisance from sewage treatment works.
- Providing guidance on good practice for assessing odour and managing and responding to complaints.

Whilst this Code of Practice provides a high-level framework for managing odour nuisance, the expertise of local authorities and operators of sewage treatment works remains essential for effective odour management on a case-by-case basis. We hope that this Code of Practice will help both operators and regulators of sewage treatment works to work together towards managing the quality of the local environment.

**Ben Bradshaw**

**Carwyn Jones**

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# **Part I**

## **Background**

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# 1. Introduction and scope

## 1.1 The aims of this Code

Odour from the majority of sewage treatment works is regulated by local authority Environmental Health Practitioners under the statutory nuisance provisions of the Environmental Protection Act 1990. Under the statutory nuisance regime there is a defence available in the event of either an appeal against an abatement notice, or prosecution for having contravened, or failed to comply with, an abatement notice, for statutory nuisance on industrial, trade or business premises, of having used “best practicable means”<sup>\*</sup> to abate the nuisance (this is notwithstanding that abatement action might still be taken by the local authority to execute an abatement notice whether or not prosecution for contravention etc of it is undertaken).

Although the achievement of zero odour around sewage treatment works may not be possible in all circumstances, there are many different means that can be used to abate odour nuisance from sewage handling facilities which include sewage treatment works, sewage pumping stations, storm water storage tanks and sludge treatment centres.

The aims of this Code of Practice are threefold:

- To provide a framework under the statutory nuisance regime in England and Wales within which the appropriate regulators and sewerage undertakers can operate, to minimise the likelihood and impact of nuisance from odours.
- To provide practical advice and a framework for local authority Environmental Health Practitioners who enforce the statutory nuisance regime.
- To set out for the public what they can expect during an investigation of a complaint of odour nuisance from sewage treatment works.

## 1.2 Who this Code is for

This Code of Practice is for all stakeholders involved with, and affected by, odour from sewage treatment works including:

### **Environmental Health Practitioners:**

Part I of this Code of Practice gives an overview of the problems and issues which may arise when checking for, or assessing a complaint of, statutory nuisance from odour from a sewage treatment works.

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<sup>\*</sup> Best Practicable Means is explained in more detail in Sections 3.1.



Part II is written to assist local authority Environmental Health Practitioners with, and inform the public about, the investigation and assessment of statutory nuisance from odour from sewage treatment works.

Parts II and III of the Code of Practice are written to assist Environmental Health Practitioners considering enforcement action against odorous works.

**The public:**

Odour complaints usually arise from members of the public. Parts I and II of this Code of Practice seek better to inform the public of the possible sources of odours and the complaints procedures they can expect sewage treatment works operators and local authority Environmental Health Practitioners to adhere to, and to give them assurance that their views are taken seriously.

Part III shows the public the complexity of the task that Environmental Health Practitioners and operators may sometimes face, and gives an indication of how statutory nuisance from odour can be addressed.

This Code explains that there will be limits to the abilities of regulators and operators to prevent or reduce odours, and that in most cases some minor odour must sometimes be expected from sewage treatment works.

**Sewage treatment works operators:**

Sewage treatment works operators have the responsibility and ability to put in place the measures to control or abate odour problems from their plant.

Part III of this Code of Practice describes a framework for sewage treatment works operators in England and Wales to meet this responsibility.

It is acknowledged that adherence to this Code of Practice may not result in zero odours around a sewage treatment works under every circumstance. In cases where further abatement of odour needs to be effected, there may nevertheless come a point where the cost may be thought disproportionate to the abatement to be achieved, or commercially prohibitive – in any event the abatement required by Environmental Health Practitioners cannot exceed that which is financially practicable. This issue may thus be central to the determination of the abatement measure to be put in place and may underpin an operator's "best practicable means" defence if he is prosecuted for contravening an abatement notice.

This Code of Practice provides sewage treatments works operators with a framework through which they can apply good practice. This Code sets out the process by which an opinion on what constitutes "best practicable means" for a site might be formed.

It is not possible for this Code or the supporting guidance to state what will constitute "best practicable means", as this is for the Courts to decide when an abatement notice is appealed against, or a prosecution is brought for contravention or failure to comply with any requirement of an abatement notice without reasonable excuse. "Best practicable means" may vary on a case by case basis.

**Planning:**

This Code of Practice outlines issues which should be taken into consideration by local authority planning authorities and developers when considering land use.

### **1.3 The status of this Code of Practice**

This is a voluntary Code of Practice in that the Secretary of State in England and the National Assembly for Wales do not currently have the power to give statutory approval to Codes of Practice on odour nuisance. Its purpose is to inform both operators and regulatory agencies and set out good practice in administering existing legislation within the statutory nuisance provisions within Part III of the Environmental Protection Act 1990.

This Code of Practice is based on the state of knowledge and understanding at the time of writing. It draws on the research work and reviews<sup>1,2</sup> carried out for Defra.<sup>3</sup> This Code of Practice and any relevant additional guidance may be amended from time to time to keep abreast of new developments.

It is important to understand that in a case of statutory nuisance from odour, it is up to the sewage treatment works operators to demonstrate that appropriate odour control measures have been used. Industry may issue its own guidance on what it considers appropriate means of control in the generality of cases, and how to apply these means to site-specific circumstances. This guidance will need to be framed so that operators can anticipate and plan to avoid statutory nuisance. Regulators will need to see that this guidance and the plans effected by operators meet the legislative requirements for statutory nuisance. When Environmental Health Practitioners are satisfied that a statutory nuisance exists or may occur or recur, the application by the operator of the provisions of this Code and any supporting guidance cannot be taken to ensure a defence in any particular case. The Court will decide, in a prosecution for the contravention of, or the failure to comply with, an abatement notice for statutory nuisance, whether measures taken by an operator in any particular situation are or are not “best practicable means” for the site in question.

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<sup>1</sup> *BAT for Odour Control at Sewage Treatment Works*, Key Environmental Management, March 2003, [www.defra.gov.uk/environment/localenv/odour/bat-odour-stw.pdf](http://www.defra.gov.uk/environment/localenv/odour/bat-odour-stw.pdf)

<sup>2</sup> *Draft BAT Guidance Note Sewage Treatment Processes*, Key Environmental Management, March 2003, [www.defra.gov.uk/environment/localenv/odour/bat-draftguide-stw.pdf](http://www.defra.gov.uk/environment/localenv/odour/bat-draftguide-stw.pdf)

<sup>3</sup> *Local Authority Guide on Odour Nuisance from Sewage Treatment Works*, Defra draft, December 2004, [www.defra.gov.uk/corporate/consult/sewageodour/](http://www.defra.gov.uk/corporate/consult/sewageodour/) .

## 1.4 What this Code of Practice applies to

### Type of nuisance

This Code of Practice focuses on odour nuisance, although many of the general principles (and in particular the step-wise Good Practice Approach in Figure 1) can be applied to any other type of statutory nuisance, such as noise and insects<sup>#</sup>.

### Type of plant

This Code of Practice applies to all sewage treatment works and other facilities where sewage is contained or handled (but not sewers) to which the statutory nuisance provisions of the Environmental Protection Act 1990 apply, regardless of the ownership, financial model and size of the companies owning those works.

This Code of Practice applies first and foremost to odour nuisance from sewage treatment works themselves, rather than to the wider sewerage network. However, where plant processes, equipment or other sources of odour from sewage treatment works are found at other points in the network, this Code of Practice is intended to apply.

### Regulated works

This Code of Practice supports the regulation of odour under the statutory nuisance regime. This Code of Practice applies only to sewage treatment works and/or plant and operations at sewage treatment works that are not currently subject to environmental regulation under other specific legislation relevant to odour.

For example, parts of a relatively small number of sewage treatment works fall under the Integrated Pollution Prevention and Control (IPPC) regime and are regulated by the Environment Agency under the Pollution Prevention and Control (PPC) Regulations. This Code of Practice does not apply to those sites and/or plant and operations at those sites\*, though operators and regulators of these installations may nevertheless find this document a useful reference. Where Integrated Pollution Prevention and Control applies, statutory nuisance does not. This avoids double jeopardy. **For the avoidance of doubt, whatever is covered by the Pollution Prevention and Control Regulations is not covered by this Code of Practice.**

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<sup>#</sup> Section 101(2) of the Clean Neighbourhoods and Environment Act 2005 amends section 79(1) of the Environmental Protection Act 1990 to include 'any insects emanating from relevant industrial, trade or business premises and being prejudicial to health or a nuisance;'. This section was commenced (and exclusions from "relevant" premises specified by Statutory Instruments) on 6 April 2006. Guidance is available at <http://www.defra.gov.uk/environment/localenv/legislation/cnea/statnuisance.pdf>. The Statutory Nuisances (Insects) Regulations 2006 can be viewed at <http://www.opsi.gov.uk/si/si2006/20060770.htm>

\* Only specific aspects of a limited number of sites are regulated under PPC. For example, a large site employing a sludge incinerator may have a PPC Permit, but that would not, for example, cover the screening or sedimentation tanks.

## **Existing works and planned works**

This Code of Practice applies to all operating facilities and makes no distinction between older works and recently built works. It is recognised that, compared to installing engineering controls at new works or during major upgrades, retrofitting odour abatement measures at existing works is usually more difficult and more costly. For the avoidance of doubt, the “baseline measures” of odour control in this Code of Practice should apply at all sewage treatment works. Further works should be applied on a risk-basis where there is a risk of odour nuisance. If further means of odour control in reaction to complaints are found to be *not* applicable to a particular works, it is because the operator has concluded and can demonstrate to the Court that “best practicable means” are already being applied if the operator appeals against an abatement notice. There should be no presumption against using odour control measures at older plants.

This Code of Practice is not intended as a design guide for planned sewage treatment works, although it is relevant where existing works are being up-rated or extended. In many cases, planning permission will be needed for such development, and the operator should consider the impact of odour from the site as a whole. It is unlikely that the statutory nuisance provisions of the Environmental Protection Act 1990 would be used for “green field” sewage treatment works at the planning stage, and accordingly this Code of Practice would not normally apply to yet-to-be built sewage treatment works. Nevertheless, it is expected that for planned new sewage treatment works, or planned substantial changes to an existing sewage treatment works – particularly in sensitive areas – operators will want to anticipate potential odour problems and build in more of the odour control means from the outset, rather than rely solely on using the provisions of this Code based on reacting to complaints which could lead to retro-fitting of controls. Further information is given in Section 3.3 on the interface between planning and odour nuisance.

## **2. An overview of the problem**

Sewage is produced as a by-product of human existence and numerous industrial processes and is odorous by nature. Although primarily water, sewage contains various other biological and chemical materials which, if released in an uncontrolled manner to the environment, are capable of causing pollution. Over the centuries the treatment of sewage has developed at defined locations to which it is delivered via a system of sewers. The production, transmission and treatment of raw sewage releases odour.

In general, older sewage treatment works were not designed specifically to limit odour in the area immediately surrounding the site boundary and many of these sites were built in areas that were then (if not now) remote from sensitive receptors. Sewage operators have, however, taken account of odour and generally operated works so that odour nuisance is controlled within the capability of the works processes. Now, in many instances, housing and other developments have significantly encroached on the land around sewage treatment works which

were originally remotely sited. This increases the number of people likely to be impacted by sewage works odour. Additionally, the public's awareness and expectation of a better environment has increased as has the belief that complaint can lead to action, particularly with a privatised industry. These factors are believed to contribute strongly to the perception that the problem of odour nuisance from sewage treatment works has been steadily increasing over the last two decades.

There are a number of other reasons that may have contributed to this perception. Prior to 1974, treatment works were mostly operated by local authorities. This self-regulation of odour issues effectively ensured the use of statutory nuisance powers to control odour releases was not possible. The creation of the Regional Water Authorities to some extent overcame this, a process taken much further by the privatisation of the water industry in 1989. Statutory nuisances, which included odours (although the word "odour" was not used), were established by the Public Health Act 1936 and continued by the Environmental Protection Act 1990, further strengthening the powers of local authorities to issue abatement notices.

Implementation of the Urban Wastewater Treatment (UWWT) Directive during the 1990s has been a key environmental driver in requiring improvement of sewage treatment plant and discharges. There has been a surge in investment in the construction of new and upgraded treatment works to meet the requirements of this Directive, some in odour-sensitive locations. There has also been an increased tendency to pump sewage further, to larger works considered more efficient. Pumping sewage over long distances encourages anaerobic conditions in contrast to the usual aerobic conditions found in gravity sewers and leads to an increased likelihood of septicity, which can result in risk of odour. There are also a number of other legislative drivers that may potentially result in higher levels of treatment than required for the Urban Wastewater Treatment Directive.

An overview of the sewage treatment works process and the potential and likely causes of odour problems at sewage treatment works are described elsewhere.

### **3. Legal framework**

#### **3.1 Control of odour by statutory nuisance provisions, including "best practicable means"**

The control of odour nuisance from sewage treatment works relies upon the statutory nuisance regime detailed in Part III of the Environmental Protection Act 1990 which is enforced by local authorities.

Statutory nuisance is a term in law. This regime requires local authorities to check their areas periodically for actual and potential statutory nuisances, and places a duty on local authorities to issue an abatement notice when satisfied that a statutory nuisance exists or may occur or recur. The abatement notice will require the execution of such works and other steps necessary to abate the nuisance or restrict its occurrence or recurrence, and must specify a timescale. Where the

statutory nuisance is one falling within section 79 (1) (d) – “any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being prejudicial to health or a nuisance” – which includes odour at sewage treatment works, the Act provides a defence for the operator upon prosecution before the Court for his contravening, or failure to comply with, an abatement notice, to demonstrate that the “best practicable means” have been used to prevent or counteract the effect of statutory odour nuisance (in similar circumstances, “best practicable means” can be pleaded before the magistrates’ court in an appeal against an abatement notice: Statutory Nuisance (Appeals) Regulations 1995 (S.I. 1995/2644)).

The interpretation of “best practicable means” is described at section 79(9) of the Environmental Protection Act 1990:

- a) *“practicable” means reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;*
- b) *the means to be employed include the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures;*
- c) *the test is to apply only so far as compatible with any duty imposed by law;*
- d) *the test is to apply only so far as compatible with safety and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances;’.*

“Best practicable means” are the methods employed to mitigate the effects of certain statutory nuisances. In effect, where a statutory nuisance is found to exist on industrial, trade or business premises, but it is an irreducible result of a necessary activity where those responsible have used the “best practicable means” available to them to reduce its impact, there can be no conviction for contravening, or failing to comply with, an abatement notice (or magistrates’ order under section 82) issued for statutory nuisance (or an appeal against service of an abatement notice may be upheld).

The “best practicable means” are not fixed and may change, for example, with advances in abatement or process technology.

Of course, a statutory nuisance may well also be an “ordinary” nuisance at common law, in which event it may still be possible for tort proceedings to be brought by persons aggrieved by the common law nuisance, but without recourse to the streamlined procedures, or the requirement for local authority intervention and enforcement, that distinguish statutory nuisance.

“Best practicable means”, when used in an appeal against an abatement notice, or as a defence to prosecution, is determined by the Court on a case-by-case basis and will be specific to the site in question. In some cases, what is considered “best practicable means” for one works *may* represent “best practicable means” for a comparable process elsewhere, but it is for the operator

to demonstrate that the methods he has employed are “best practicable means” for that site, and for the Court to decide if it agrees that this is the case.

Further guidance is included in Part II of this Code of Practice on the investigation and assessment of odour problems. The procedures and controls outlined in this Code of Practice (particularly in Part III) establish an approach to dealing with statutory nuisance from odour. Having said that, compliance with this Code cannot guarantee that a Court will agree with the operator that “best practicable means” are being employed, should the operator demonstrate that he has complied with the provisions of this Code and Guidance.

Under section 80 of the Environmental Protection Act 1990, the Environmental Health Practitioner *cannot* delay issuing an abatement notice once “satisfied” that a statutory nuisance exists or may occur or recur. Therefore, this Code cannot require an Environmental Health Practitioner, once he is “satisfied” that a statutory nuisance exists or may occur or recur, to delay issuing an abatement notice until “best practicable means” is proved or otherwise. Nor can this Code require an Environmental Health Practitioner to pin-point sources of or reasons for odour – it is sufficient for him to attribute statutory nuisance from odour to a “premises”.

This Code seeks to set up practices that avoid court cases and encourage the adoption of approaches that satisfy all stakeholders and allow effective regulatory function. The view taken by an Environmental Health Practitioner might be considered unsatisfactory by an operator. Even so, Environmental Health Practitioners generally try to work with operators to agree a course of action on an informal basis before taking formal enforcement action. There are also cases where issuing an abatement notice may aggravate or worsen a situation. Both local authorities and operators generally prefer to avoid court action.

An abatement notice once issued may simply require abatement without specifying works or other steps necessary. It should allow sufficient time for action to be taken by the operator, which might include staged implementation to achieve economical and sustainable solutions. In addition, an abatement notice should where possible support the minimal use of non-renewables and minimal energy impact. These objectives complement the use of cost-benefit assessments that operators are required to carry out by Ofwat, and aim to produce socially beneficial and sustainable solutions.

In circumstances where a local authority is of the opinion that prosecution (for ignoring an abatement notice) under section 80(4) of the Environmental Protection Act 1990 would afford an inadequate remedy, section 81(5) of the Environmental Protection Act 1990 allows injunctive action to be taken. This would entail the local authority taking proceedings in the High Court and circumvents the “best practicable means” defence at section 80 (7).

Section 82 (1) of the Environmental Protection Act 1990 allows any person aggrieved by the existence of a statutory nuisance to seek an order from magistrates requiring the abatement or cessation of the nuisance, and to prohibit its recurrence.

### 3.2 Sewage treatment works subject to other statutory controls

This Code of Practice is intended to apply to those sewage treatment works that are not currently subject to environmental regulation under other legislation. A relatively small number of sewage treatment works fall under the Integrated Pollution Prevention and Control (IPPC) regime and are regulated by the Environment Agency under the Pollution Prevention and Control (PPC) Regulations. Whereas regulation by the statutory nuisance regime is largely (though not entirely) reactive (it allows action where a nuisance exists, or is likely to exist or recur), the powers under Integrated Pollution Prevention and Control regime are proactive and enforced by a system of licensing and permitting of processes, with conditions put in place for all aspects of the design, operation and management of the processes.

The Pollution Prevention and Control Regulations require that certain operations for the treatment of waste be subject to the Integrated Pollution Prevention and Control regime. The definition of installations, subject to these controls, included in the Pollution Prevention and Control (England & Wales) Regulations 2000 (S.I. 2000/1973) are outlined below:

- (a) *The disposal of hazardous waste (other than by incineration or landfill) in a facility with a capacity of more than 10 tonnes per day.*
- (b) *The disposal of waste oils (other than by incineration or landfill) in a facility with a capacity of more than 10 tonnes per day.*
- (c) *Disposal of non-hazardous waste in a facility with a capacity of more than 50 tonnes per day by –*
  - (i) *biological treatment or*
  - (ii) *physico-chemical treatment.*

**For the avoidance of doubt, it should be reiterated that this Code of Practice does not apply to the above sites. This section has been provided for background information only. Separate guidance on the applicable standards for such Integrated Pollution Prevention and Control processes is provided by the Environment Agency.**

### 3.3 Planning controls and amenity

Planning controls interface with the issue of odour from sewage works in two ways.

New sewage treatment works (and often improvements to existing sewage treatment works) require planning permission. There is a long-standing principle that the planning system should not be operated so as to duplicate the statutory responsibilities of other, more appropriate, pollution control agencies. For those sewage treatment works subject to the Integrated Pollution Prevention and



Control regime, the latter will ensure that control measures are implemented to avoid the causing of odour annoyance.

However, this Code of Practice is concerned with those sewage treatment works *not* subject to Integrated Pollution Prevention and Control (which form the vast majority). For these works, it may be appropriate to use planning conditions to require inclusion of odour control measures and to establish appropriate operating conditions. Planning issues are dealt with by Planning Policy Statement (PPS) documents issued by the Office of the Deputy Prime Minister (ODPM), and not by this Code of Practice. Of particular relevance is Planning Policy Statement 23<sup>4</sup> on planning and pollution, which applies in England, and Planning Policy Wales in Wales.

Secondly, there is the issue of proposed or actual development close to sewage works (often termed “encroachment”). Planning Policy Statement 23 states that local planning authorities need to consider carefully the proximity and location of existing developments, such as sewage treatment works, when drawing up plans to allocate new development. Such development may be affected by odour from the works and a statutory nuisance created where it did not exist before. Encroachment of odour-sensitive development around sewage treatment works can lead to significant problems, with existing sewage treatment works becoming subject to complaints, perhaps for the first time. At the same time, people in the area who may be affected by statutory odour nuisance need protecting by their local authority whose responsibility it is to enforce the abatement of statutory nuisances. Customers and water companies also need protecting from effectively financing the upgrade of local environment land sold “cheap” to developers, through charging higher customer water bills to fund the cessation or abatement of an ensuing statutory nuisance. In some cases, an operator may itself have sold the land for development and indirectly introduced new receptors. The occupiers of any new development are likely to expect and demand high amenity standards and this could result in complaints. Differing circumstances between individual works makes a standard distance ‘cordon sanitaire’ difficult. However, individual buffer zones can offer a practical means of preventing the exacerbation of existing problems and the occurrence of new ones. The operational and complaints history of a sewage treatment works and other potential odour issues should be carefully considered by Planning Authorities before permitting new development in the immediate vicinity (assuming a record exists, given that development may not previously have occurred).

Planning Authorities may find themselves in the difficult position of feeling pressurised to release land for development. Planning Authorities should consider resisting development close to works where there is a significant risk of likely statutory nuisance from odour. This Code considers that it would be good practice for Planning Authorities if they do not already do so to consult Environmental Health Authorities and sewerage companies before development around sewage treatment works is permitted. Indeed, operators of sewage treatment works should be aware of proposed developments and have the opportunity to comment on any

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<sup>4</sup> Planning Policy Statement (PPS) 23, *Planning and Pollution Control*, Office of Deputy Prime Minister, 2004, ISBN 0 11 753927 9.

land allocations through the consultation process by which Local Development Documents are drawn up. In addition, operators of sewage treatment works can comment on any planning application proposals through the public consultation mechanism. It would be strongly advisable for any applicant planning development near a sewage treatment works to hold pre-application discussions with the operators and local planning authority; developers will not want to build houses that are unsaleable.

It should also be noted that sewage treatment works are listed in Schedule 2 of the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 (S.I. 1999/293). Schedule 2 Developments are those that may require an environmental assessment depending on whether they exceed indicative criteria. DETR Circular 02/99 'Environmental Impact Assessment' provides guidance on the regulations and in particular A39 of 02/99 concerns itself with waste-water treatment plants and states that in considering whether an Environmental Impact Assessment is required:

*'Particular consideration should be given to the size, treatment process, pollution and nuisance potential, topography, proximity of dwellings and the potential impact of traffic movements. An Environmental Impact Assessment is more likely to be required if the development would be on a substantial scale (e.g. site area of more than 10 hectares) or if it would lead to significant discharges (e.g. capacity exceeding 100,000 p.e.). An Environmental Impact Assessment should not be required simply because it is on a scale requiring compliance with the Urban Waste Water Directive'.*

### **3.4 Ofwat and price controls on the water industry**

The Office of Water Services (Ofwat) is the economic regulator of the water industry in England and Wales. Ofwat is a non-ministerial Government Department working with the Government, the Welsh Assembly Government and the quality regulators (the Countryside Council for Wales, the Drinking Water Inspectorate, English Nature, the Environment Agency and the Consumer Council for Water) to ensure that the regulated water and sewerage companies provide customers with "a good-quality, efficient service at a fair price".

Ofwat consults widely on the issues that affect water and sewerage price regulation and odour abatement is no exception. Ofwat can be expected to develop its regulatory policy in relation to odour control and abatement.

Ofwat's primary duty is to make sure that water and sewerage companies are able to carry out and finance their functions under the Water Industry Act 1991. As part of this duty Ofwat reviews price limits for water and sewerage periodically, currently every 5 years. Price limits for charges to customers are set to provide sufficient revenue to finance companies' spending on capital expenditure and their day-to-day operations. Ofwat consults widely, including with the Consumer Council for Water, during the price review process to gain feedback on customers' views on proposed company investment and evidence of customer support for investment in enhanced service levels.

As with the many pressures for maintaining and enhancing the service, and the business risk faced by water and sewerage companies, Ofwat will seek to ensure that a proper balance is struck between the general public interest, as represented by water customers' bills, the private interests of those affected by a particular set of operations of the sewerage companies, and the financial risk carried by the companies themselves.

As part of this process, in order to determine the impact that proposals for reducing odour levels should have on water and sewerage *price limits*, Ofwat will challenge companies' proposals including requiring a robust cost-benefit justification for each significant proposal to abate odour. Ofwat also requires companies to show that their proposals are no more than is reasonably required, by using a staged approach to implementation wherever practicable.

Ofwat cannot challenge or supplant the decisions of Environmental Health Practitioners. Ofwat has to determine the reasonable balance of cost and risk between the company and its customers generally. Ofwat considers that a robust cost-benefit assessment, taking a risk-based economic approach and due note of environmental sustainability objectives, is a necessary component of this process. There may be cases where the conclusions of a robust cost-benefit assessment coincide with other assessments, such as those of the Environmental Health Practitioner or Courts. The process will expose cases where the statutory nuisance assessment demands expenditure beyond what is considered by the operator or Ofwat to be cost-beneficial and Ofwat will need to take this factor into consideration. The cost-benefit process will also enhance regulators' understanding of the social and environmental value to be derived from particular odour abatement proposals and from such proposals generally. This knowledge will assist the legislature in determining priorities for social and environmental improvements.

It is not the case that approval by Ofwat is required before works to address statutory nuisance can be undertaken by operators. The role of Ofwat does not affect the legal status of the statutory nuisance or abatement notice. If an abatement notice has been issued, then the operator has a legal obligation to comply with it, and the operator commits an offence if he fails to comply with or breaches the abatement notice without reasonable excuse, unless it is overturned by the court on appeal or withdrawn by the local authority. In addition, some measures to address statutory odour nuisance may have very little cost impact and need not affect customer bills. In addition, operators have access to a variety of funding mechanisms apart from "additional funding" through customer bills, e.g. reallocation of resource priorities, efficiency gains, borrowing and profits. Regulated sewerage companies may need to fund abatement measures and invoke the regulatory price adjustment mechanisms that may be available to them.

The regulatory requirements of Ofwat and, in particular, the use of cost-benefit assessment aligns closely with the project-specific analysis that an operator should use to assist the selection of what he considers an appropriate degree of odour abatement or control, and the cost-effective assessment needed to select the best value measures to meet the abatement objective. Where this assessment concurs with the view of the Courts, the operator will have anticipated “best practicable means” to the satisfaction of that regulator.

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## **Part II**

# **Assessment of odour nuisance from sewage treatment works**

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## 4. What is odour?

### 4.1 Introduction

An odour can be due to a single chemical species in the air; it can be due to a dominant odorous chemical species among many other essentially non-odorous substances; or it may be a mixture of several or many substances, some or all of which may be odorous. Some odours are more unpleasant than others and have more potential to cause offence or nuisance. It is necessary to have an appreciation of how we perceive odour, and how several characteristics of odour are interlinked in order to understand the potential for offence and nuisance.

### 4.2 How we sense odour

Odour is perceived by our brains in response to chemicals present in the air we breathe. Odour is the effect that those chemicals have upon us. Humans have a sensitive sense of smell and can detect odour even when chemicals are present in very low concentrations. Most odours are a mixture of many chemicals that interact to produce what we detect as an odour. The human sense of smell is caused by an interaction between molecules in the air and receptor cells located in the nose. These cells are attached to the olfactory bulb, which lies at the top of the nose, at the base of the brain. The direct connection between the olfactory organ and memory and emotional centres of the brain goes some way towards explaining the often-emotional response to odours and the way in which they can often be evocative.

### 4.3 The characteristic attributes of an odour

The following interlinked sensory characteristics are conventionally used to describe how we perceive an odour.<sup>5, 6</sup>

#### i. Odour concentration and intensity

##### **Concentration**

This is the amount of odour present in a given volume of air. For a known, chemical species this can be expressed either as the volume of that compound per unit volume of air (e.g. parts per million, ppm, or parts per billion, ppb) or the mass of that compound per unit volume of air (e.g. milligrammes per cubic metre,  $\text{mg}/\text{m}^3$ , or microgrammes per cubic metre,  $\mu\text{g}/\text{m}^3$ ). However, most odours are complex mixtures of compounds and for these a different measure of concentration is needed. Convention is to use European odour units per cubic metre of air ( $\text{ou}_E/\text{m}^3$ ). This is the number of repeated dilutions needed with a fixed amount of odour-free air or nitrogen, until the odour is just detectable to 50% of a

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<sup>5</sup> Hobson and Yang, *Odour Control in Wastewater Treatment – a Technical Reference Document*, UK Water Industry Research, 2001.

<sup>6</sup> Stuetz and Frechen (Eds). *Odours in Wastewater Treatment, Measurement, Modelling and Control*, Publ. IWA, 2001, ISBN 1 900222 46 9.

panel of trained observers, following strictly the requirements of the European Standard<sup>7</sup> for the technique of olfactometry.

### ***Intensity***

This is how an individual person perceives the magnitude (strength) of an odour, going from faint to strong. A standard method<sup>8</sup> exists for ranking intensity on a scale from faint to strong by a panel of trained observers. Although intensity increases with concentration, there are two important points to be borne in mind:

Firstly, an odour can smell stronger than another odour present at the same concentration. This is because odours have different “specific intensities”.

Secondly, the relationship between odour intensity and concentration is logarithmic and an increase or decrease in concentration will not always produce a corresponding proportional change in odour strength as perceived by the human nose. This has important implications for control. An odour with a strong intensity at low concentrations may cause odour problems even at low residual levels. For example, increasing the concentration of an odorous chemical or mixture by a factor of 10 may only increase its perceived intensity by a factor of 2. Conversely, if a site is causing odour pollution in a community, abatement equipment may have to reduce odour concentrations at the sensitive receptors by 90% in order to halve the intensity of odour they perceive<sup>4</sup>.

### ***Odour character***

This is basically what the odour smells like. Odour character or quality is that property that identifies an odour and differentiates it from another odour of equal intensity. For example, ammonia gas has a pungent and irritating smell. The character of an odour may change with dilution. Odour is characterised by either the degree of its similarity to a set of reference odours or the degree to which it matches a scale of various “descriptor” terms. The result is an odour profile. Examples of odour descriptor terms include “fishy”, “cabbage-like”, “almond” or “fruity”. These can be useful for pinpointing an odour’s source from a complainant’s description. They can also be useful in pointing to likely key chemical compounds contained in the odour.

### ***Hedonic tone, unpleasantness and relative-offensiveness***

Hedonic tone is the degree to which an odour is perceived as pleasant or unpleasant. Such perceptions differ widely from person to person, and are strongly influenced, among other things, by previous experience and emotions at the time of odour perception. This is related to (but not synonymous with) the relative pleasantness or unpleasantness of an odour. A standard method<sup>9</sup> exists for ranking hedonic tone on a scale ranging from very pleasant (score of +4, e.g. bakery smell) through neutral to highly unpleasant (score of -4, e.g. rotting flesh) by a panel of trained assessors. It has been observed, however, that outside of

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<sup>7</sup> BS EN 13725: 2003, *Air Quality - Determination of Odour Concentration by Dynamic Olfactometry*.

<sup>8</sup> VDI 3882: 1997, Part 1: *Determination of Odour Intensity*, Beuth Verlag, Dusseldorf, Germany.

<sup>9</sup> VDI 3882: 1997, Part 1: *Determination of Odour Intensity*, Beuth Verlag, Dusseldorf, Germany.

the laboratory this parameter can be subject to substantial variations between individuals. Furthermore, some odours may be pleasant when weak but unpleasant when strong, or when exposure is frequent.

Because it is a quantitative measure, odour concentration is used in a number of assessment tools (see Section 5.2.2). Some additional terms are used to characterise particular odour concentrations, such as:

- the odour detection threshold - the concentration of any specific chemical or mixture at which it can be ascertained that an odour is present, i.e. the level that produces the first sensation of odour; and
- the recognition threshold - the concentration at which an odour becomes recognisable is generally higher than the odour detection threshold.

## **4.4 Characteristics of odour from sewage treatment works**

### **4.4.1 Typical odorous species**

There are many chemical species that have been detected in sewage treatment works odours. In addition to hydrogen sulphide and other pollutants such as ammonia, there are a wide variety of organic sulphides and organic nitrogen-based compounds along with some oxygenated organic compounds and organic acids.

In addition to these compounds, there are many potential substances which may be released depending upon the quality of the influent, for example if it includes industrial effluent. The range of contaminants potentially present in industrial effluent is extensive but those which are likely to be of concern are already odorous liquids (such as wastewater from food production), warm effluent which may accelerate anaerobic conditions and volatile organic compounds such as solvents and petroleum derivatives.

The primary odours from sewage treatment works are biogenic due to the degradation of organic matter by microorganisms under anaerobic conditions. The development of anaerobic conditions in sewage is often referred to as 'septicity'. Septicity can be onset by elevated temperature, high biological oxygen demand, high sulphate levels and the presence of reducing chemicals. Anaerobic activity leads to the production of methane, hydrogen sulphide (H<sub>2</sub>S), ammonia (NH<sub>3</sub>), organic sulphur, thiols (mercaptans), amines, indole and skatole. During the fermentation phase of anaerobicity, volatile fatty acids, alcohols, aldehydes and ketones can be produced.

However, odour which is not typical of anaerobic conditions can also be generated by other mechanisms in a treatment works including:

- volatile substances in the influent such as petroleum derivatives, solvents;
- air stripping of volatile compounds and odours particularly from industrial effluent often at inlet works or during aeration;



- aerobic odours – which are often described as a ‘musty’ odour; and
- ammonia odour from reactions after liming of sludges or when sludges become re-wetted.

#### 4.4.2 Hydrogen sulphide (H<sub>2</sub>S)

Hydrogen sulphide is often referred to as the cause of odour from sewage treatment works. Whilst hydrogen sulphide may be a principal component of the odour cocktail, there are other compounds which cannot be ignored. Because it is relatively easy to measure, H<sub>2</sub>S is often used as a target indicator for odour but there are important limitations to this technique.

## 5. When does odour become a nuisance?

### 5.1 Terminology: statutory nuisance, offensiveness and annoyance

A number of terms are used to describe the impacts of odour, including statutory nuisance, annoyance and offensiveness. It is important to understand where the differences and similarities lay. Odours amounting to a nuisance are likely to be offensive, but offensiveness is not an obligate characteristic of nuisance.

A statutory nuisance from odour is an odour arising on industrial, trade or business premises that has been assessed by an Environmental Health Practitioner as being “prejudicial to health or a nuisance”. In effect, a statutory nuisance is such that it prevents someone from enjoying his own property (nuisance) or has prejudicial health effects on a normally healthy person or persons in the area. Statutory nuisance does not *depend* on the number of complaints, though this is likely to be a factor the Environmental Health Practitioner takes into account in making his assessment. A statutory nuisance may be found to exist, or be likely to occur or recur, with only one complaint, or even none.

The term “offensiveness” of an odour encompasses the factors that determine whether an odour has an objectionable or offensive impact\*. It includes the frequency, intensity (and therefore concentration), duration, hedonic tone/character, along with the location. Once the odour detection threshold has been exceeded (on an individual level) the offensiveness of a particular odour will be related to its perceived intensity and its hedonic tone.

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\* It should be noted that the term “offensiveness” also has another meaning. It is sometimes used to describe just the character and unpleasantness of an odour, so it is related to the hedonic tone. When used in this context, the term “relative offensiveness” is sometimes used. However, to avoid confusion, it is preferable to use the term “odour unpleasantness”.

Although some odours are classified by their hedonic scores as highly unpleasant and others as very pleasant, it should be remembered that all odours have the potential to be statutory nuisances, depending on such factors as concentration, duration and frequency of exposure, the context within which exposure takes place (e.g. at meal times, when feeling unwell) and other factors unique to the individual. So, for example, an odour with quite a pleasant hedonic score could be perceived as a statutory nuisance if exposure is, for example, frequent and at high concentration.

“Offensiveness” is a term used in the Pollution Prevention and Control (England and Wales) Regulations 2000 (S.I. 2000/1973), which include “*emissions as a result of human activity which...cause offence to any human senses*” in their definition of “pollution” (reg.2(1)). The Environment Agency has given special consideration as to how the endpoint of odour “offence” may be anticipated, measured and assessed and this leads on to the concept of “annoyance”. The point at which pollution in the form of offence to the sense of smell is occurring is the point at which there is “*reasonable cause for annoyance*”. The aim of odour control is therefore to ensure there is “*no reasonable cause for annoyance*”. This benchmark criterion of “*no reasonable cause for annoyance*” does not necessarily equate to no complaints - it is designed to be a level of exposure that a high proportion of the exposed population, with normal sense of smell, finds “acceptable” on a long-term basis. Conversely, the lack of complaint should not necessarily imply the absence of an odour problem, as there will be an underlying level of annoyance before complaints are made. **It must be stressed that the criterion of “no reasonable cause for annoyance” does not apply to statutory nuisance, and is not the relevant benchmark for this Code of Practice.** Nevertheless, it is helpful to mention the concept in order to understand the differences.

## 5.2 Odour as a statutory nuisance

### 5.2.1 Factors suggesting whether an odour is a statutory nuisance

Just because an odour is perceived as offensive does not necessarily mean it is a statutory nuisance. Neither does an odour have to be perceived as offensive in order to be a statutory nuisance. However, there will come a point with increasing offensiveness where statutory nuisance is more likely to be caused.

A decision must be made on at what point a smell becomes “*prejudicial to health or a nuisance*”. The judgement on whether a statutory nuisance is occurring should be founded on common sense, and should be reasonable in all the circumstances (although the judgement will also be informed by legal precedents).

The factors proposed in guidance<sup>10</sup> to help an Environmental Health Practitioner determine whether a noise problem amounts to a statutory nuisance can also be applied to odour, as for any other potential statutory nuisance.

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<sup>10</sup> Noise Management Guide (England), Chartered Institute of Environmental Health/Defra 2006

Table 1 below outlines the “FIDOL” factors that are useful in determining “offensiveness, and the factors that should be taken into account when assessing a case of potential statutory odour nuisance. The FIDOL factors are **f**requency, **i**ntensity (and therefore concentration), **d**uration, relative **o**ffensiveness (hedonic tone/character) and **l**ocation, along with any aggravating characteristics. Although an odour does not have to be offensive in order for it to constitute a statutory nuisance, there are similarities between the criteria.

**Table 1. Relating odour offensiveness to statutory nuisance**

<b>The `FIDOL` factors determining offensiveness</b>	<b>Factors determining Statutory Nuisance<sup>12</sup></b>	<b>Comments</b>
Frequency (How often an individual is exposed to odour)	Frequency (How often an individual is exposed to odour)	Even an odour with quite a pleasant hedonic score can be perceived as a statutory nuisance if exposure is frequent. At low concentrations a rapidly fluctuating odour is more noticeable than a steady background, i.e. is an aggravating factor.
Intensity (The perceived strength of the odour, proportional to concentration)	Level of odour	Factors are equivalent
Duration (The length of a particular odour event. Duration of exposure to the odour)	Duration	Factors are equivalent
Offensiveness (relative)/character (Offensiveness is a mixture of odour character and hedonic tone at a given odour concentration/intensity)	Type of odour	An odour need not be offensive to constitute a statutory nuisance. Odour from sewage treatment works may be experienced as offensive because of its source
Location (The type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor.)	The characteristics of the neighbourhood where the odour occurs	Factors are essentially equivalent
	The sensitivity of the complainant	Statutory nuisance uses the concept of the average, reasonable person

### 5.2.2 Tools for estimating odour significance

The first stage in determining whether the odour constitutes a statutory nuisance is to assess the impact of the odour on the complainant of the odour, taking into account the factors summarised in Table 1. In the first instance, this assessment can be made simply by visiting the complainant. There are in addition a number of tools which may support this process, which are summarised in Table 2. Each of these tools has its own advantages and limitations that must be taken into account when considering an effective assessment strategy. For example, some of these

techniques are predictive, while some tools may be able to draw inferences on historical events. Some of the techniques are qualitative, whilst others give quantitative, numerical data.

It is very difficult to predict when a situation will lead to a statutory nuisance. Many tools involving prediction (e.g. modelling) are less effective for the endpoint of statutory nuisance than they are for the Pollution Prevention and Control endpoint of “*no reasonable cause for annoyance*”. However, real-time tools (e.g. direct sensory assessments in the field using the “sniff test”) and retrospective techniques (e.g. complaints monitoring) are likely to be very effective.

It is important not to look at these tools/techniques in isolation. They work best when brought together. Confidence in the conclusions can be increased by using multiple assessment tools.

**Table 2. Main tools available to estimate the significance of odour<sup>11</sup>**

Confidence	Tool	Comments
Qualitative	Complaints monitoring - the level of complaints from surrounding sensitive receptors.	<p>Factors to be taken into account should include:</p> <ul style="list-style-type: none"> <li>• The “quality” of a complaint (hypersensitive individuals, vexatious complaints from individuals);</li> <li>• The volume of complaints against the alleged nuisance;</li> <li>• The frequency of complaints against the alleged nuisance;</li> <li>• Repeat complaints against the alleged nuisance;</li> <li>• The frequency of odours, e.g. is it a one-off event or a regular occurrence?</li> <li>• Knowledge of potential sources on the sewage treatment works - tie-up with any plant problems and wind direction <i>cf</i> sewage treatment works and complainant, distance of complainant from site;</li> <li>• Knowledge of potential sources other than the sewage treatment works, to allow assessment of whether the sewage treatment works is the likely source or not.</li> </ul> <p>Refer to Section 6.1 for more details. A documented complaints procedure is required – see Section 6.2.</p>
Qualitative	Population surveys, odour diaries, etc.	See Section 9.2, Step 9 for further details.
Semi-quantitative	Field odour assessment using “sniff test”	In practice this is likely to be the main tool used by Environmental Health Practitioners to corroborate odour impact. A standard VDI method <sup>12</sup> exists for an offensiveness test.

<sup>11</sup> See also Environment Agency Technical Guidance Note H4.

<sup>12</sup> VDI 3940: 1993, *Determination of Odorants in Ambient Air by Field Inspection*, Pub. Verein Deutscher Ingenieure, Dusseldorf. Available from Beuth Verlag GmbH, Berlin.

Quantitative	Computer dispersion modelling	Really intended as a predictive tool to assess the impact of proposed plant. Requires the input of source emission data that may not be easily available to Environmental Health Practitioners. Allows comparison with numerical odour standards – see Section 5.3.2.1 for advantages and disadvantages of this.
Quantitative	Ambient air quality monitoring at the receptors	This is very difficult to carry out in a way that enables valid conclusions to be drawn – see the <i>Local Authority Guide on Odour Nuisance from Sewage Treatment Works</i> <sup>4</sup> . Also requires the use of numerical odour standards – see Section 5.3.2.1 for advantages and disadvantages of this. <b>Note that dynamic olfactometry cannot be used for ambient monitoring.</b>

### 5.2.3.1 Numerical air quality standards for use with modelling and monitoring

If computer dispersion modelling or ambient monitoring is carried out as a tool to estimate the significance of the odour, quantitative results will be obtained and it will be necessary to compare these against some kind of numerical acceptance criterion. There is no statutory limit in England and Wales for ambient odour concentration, whether set for individual chemical species or for mixtures. However, some guideline limits and custom-and-practice standards have been used in some circumstances. A summary is given below. Though these may be indicative of a nuisance, they are not definitive.

#### ***Odour concentration guidelines for specific compounds***

Guideline values for limiting odour annoyance have been published by the World Health Organisation<sup>13</sup> (WHO), but these are for a small number of single compounds rather than compounds in mixtures.

#### ***Ambient concentration guidelines set in Odour Units***

Mixtures of odorous compounds need to be measured in concentration units of  $ou_E/m^3$ . There are no mandatory numerical standards set in the UK in such odour concentration units for ambient air, although some “custom and practice” guideline values have been used for assessing the odour impact predicted by computer dispersion modelling. It is not possible to use olfactometry to carry out ambient monitoring of odours at the sensitive receptors\* themselves to compare with the guideline standards.

<sup>13</sup> *Air Quality Guidelines for Europe*, World Health Organisation, Second Edition, 2000, ISBN 92 890 1358 3.

\* “Sensitive receptors” are people who are potentially exposed to odour from a given source.

### **5.2.3.2 Acceptance criteria for use with other odour assessment tools**

Where odours cannot be measured or predicted in a quantitative way, comparison with a numerical concentration benchmark is not possible. Other ways must be found of assessing the significance of the odour.

For field odour assessments carried out using the “sniff test”<sup>\*</sup>, an existing standard method exists<sup>13</sup>. The odour intensity is recorded on the VDI scale (ranging from 0 = no odour to 6 = extremely strong) every 10 seconds over minimum 30-minute period at each location. This provides short-term information on frequency, intensity and duration factors.

There are two approaches to dealing with sniff test data: the first takes into account only whether the odour is recognisable - no additional weighting is given to intensity. The frequency of recognisable odour is calculated and compared with a frequency limit value. No statutory frequency limit has been set in England and Wales, although a frequency limit of 10% for residential and mixed areas and 15% for trade and industrial zones has been used in other European countries. The alternative approach involves additionally logging the intrinsic nature or odour character of the odour (such as fishy, sewage, bakery, etc), using a table of general odour character descriptions. The investigator can then summarise the overall impact (offensiveness) of the odour at the receptor.

For complaints monitoring, refer to Section 6.3 for assessing the significance of the odour .

## **6. Odour complaints**

### **6.1 The role of complaints in local authority regulatory control**

Environmental Health Practitioners have a statutory duty to take reasonable steps to investigate complaints of nuisances in their areas.

There are two important aspects to odour complaints. First is a mechanism for dealing with complaints in a fair and objective way. This should be by an odour complaints action procedure. Receipt of a complaint is often the first indication an Environmental Health Practitioner will have that there is a possible odour problem with a site. It is important that complaints are properly and systematically dealt with, and acted upon. Section 6.2 describes the essential components of a complaints action procedure for local authorities. The sewage treatment works operator should also take action to address an odour complaint and this is dealt with in Section 8.2.

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<sup>\*</sup> There is currently a lack of consistency in terminology. As well as being termed “sniff testing”, the technique has also been referred to variously as subjective testing, sensory testing, field odour assessment and simplified olfactometry. The latter should not be confused with dynamic olfactometry, which gives a fully quantitative measure of odours at source but is of insufficient sensitivity for ambient air samples and cannot be used therefore at site boundaries.

Secondly, the monitoring of complaints is an important tool for assessing the level of odour offence (as described in Section 5.2.2.). Complaints monitoring and assessment is explained in Section 6.3.

## **6.2 Odour complaints action procedure for local authorities**

The local authority should have in place a procedure specifying how any complaints will be administered, validated and progressed. This should show who is responsible for dealing with the different aspects of the complaint. For example:

- where in the local authority are complaints to be directed to as a point of central contact;
- who in the local authority has management responsibility for ensuring complaints are assessed and dealt with;
- who in the local authority has technical responsibility for dealing with complaints including their significance, for liaison with the company/site on progress (from acknowledgement of complaint to resolution where assessed as a nuisance) and is responsible for liaison with other stakeholders;
- what steps the Environmental Health Practitioner will follow from receipt of a complaint to a decision on whether or not odour statutory nuisance exists or may occur or recur.

It is important that the complaints assessment procedure is as objective as practicable. Ideally, the Environmental Health Practitioner and operator of the sewage treatment works would each come to the same conclusion on whether the complaint indicates a significant odour problem. However, it is the statutory duty of the Environmental Health Practitioner to determine whether or not a statutory nuisance exists or may occur or recur. This statutory duty cannot depend on operator agreement. Indeed, agreeing that such a problem exists might be interpreted as admitting liability for statutory nuisance on the part of the operator, which might be an unreasonable expectation.

The sewage treatment works operator should also be taking action to address odour complaints, and this is dealt with in Section 8.2.

## **6.3 Complaints monitoring and assessment**

Complaints are a very important indicator of community dissatisfaction (although not the only one). Complaints monitoring is a very useful tool in assessing whether statutory nuisance is being caused. It therefore has a place in any odour assessment, bearing in mind that odour assessment tools work best when brought together, and confidence in the conclusions can be increased by using multiple assessment tools.

It is best to think of complaints as monitoring data. It is necessary to develop a strategy to optimise the quality of the data, bearing in mind that it is difficult to dictate where the complaints will go, whether multiple complaints will occur, and

whether someone who is annoyed will complain or not. It is also necessary to think about how the complaints data will be interpreted once received. Some of the issues that need to be considered when assessing complaints, or monitoring levels of complaints, are discussed below. However, this is a developing field and future research work is likely to contribute further to understanding.

**Volume of complaints**- consideration needs to be given on how to give due weight to the volume of complaints against the alleged nuisance. It may not be sufficient to assess nuisance simply by counting up the total number of complaints. For example, 50 complaints from the same person might be handled differently to 50 complaints from different people. Judgement should be used as to the character of various complaints.

It is important to recognise that absence of statutory nuisance does not necessarily equate to no odour complaints at all, and in some circumstances an odour may be assessed by an Environmental Health Practitioner as being a statutory nuisance in the absence of any complaints. It is not possible to define an absolute threshold level of complaints that will be indicative of statutory nuisance. That will depend on whether evidence gathered on the alleged facts from those affected, and an assessment of those complaints, plus any accompanying investigation, concludes that the odour is prejudicial to health or a nuisance, taking into account the FIDOL factors and those other criteria used for assessing statutory nuisance. The FIDOL factors are **f**requency, **i**ntensity (and therefore concentration), **d**uration, relative **o**ffensiveness (hedonic tone/character) and the **l**ocation, along with any aggravating characteristics. Factors used in assessing statutory nuisance include **frequency, intensity, duration, character, local environment, time of day, impact, and sensitivity of sufferer.**

**Factors affecting human response** - response to an odour varies greatly from individual to individual. Every community will also have individuals who are more sensitive or find any detectable levels of wastewater odours objectionable. For a particular odour, approximately 2% of the population are likely to be hypersensitive and 2% anosmic (unable to detect any odour). The existence of a small percentage of hypersensitive individuals and the possibility of vexatious complaints adds to the difficulty of assessing whether complaints are indicative of statutory nuisance. It should be noted that statutory nuisance relies on the concept of the average, reasonable person. It is not designed to take account of hypersensitive individuals. In addition to sensitivity, adaptation to the odour is an important factor affecting human response. This is of course as relevant to an Environmental Health Practitioner investigating a complaint as it is to a member of the public.

**Distorting factors** - there are many reasons why persons suffering from odours might not complain. Possible reasons include:

- a lack of confidence that a complaint will bring about any improvement;
- fear of attacks against their reputation;



- uncertainty over whom to complain to;
- concern for unintended consequences such as a lowering of property values if the problem were to feature prominently in the press.

To be able to use monitoring of complaints as an effective assessment tool, barriers to complaints need to be lowered whenever possible.

On the other hand, the local authority should be aware that, whilst organised campaigns probably indicate a serious local problem, they may also distort the conclusions drawn from complaints monitoring. An investigating Environmental Health Practitioner may wish to contact the Consumer Council for Water in case there is supporting evidence from the relevant regional office to help assess the due weight to give to complaints of odour nuisance, as some regional offices record data on odour complaints. An absence of supporting evidence does not mean that no complaints have been made, as not all complainants would think to contact the Consumer Council for Water and not all regional offices of the Consumer Council for Water record such data. Neither does an absence of supporting evidence mean that a statutory nuisance does not or will not exist. A presence of supporting evidence may, however, help the assessment process.

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## **Part III**

# **Control of odour from sewage treatment works**

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## 7. Main approach and structure of Part III

### 7.1 The main approach

The main philosophy behind Part III of this Code of Practice is that sewage treatment works operators should use appropriate means to prevent odour nuisance, and (where that is not possible) to abate odour emissions with the aim of ensuring that the nuisance is minimised. The appropriate means to control potential or actual statutory odour nuisance should be “best practicable means” so far as the operator is able to identify it (bearing in mind that only the courts are able to decide authoritatively whether a particular measure meets the defence of “best practicable means” for a given situation).

“Best practicable means” may include:

- the general management of the sewage treatment works;
- the design, installation and maintenance of plant, buildings and structures;
- the operation of the sewage treatment works and its processes;
- engineering solutions, e.g. containment, enclosure with venting and end-of-pipe treatment (e.g. disperse and dilute, or abatement).

In anticipating what “best practicable means” might be, operators of sewage treatment works should take into consideration local conditions and circumstances, the current state of technical knowledge, and the financial implications so that the costs do not become commercially prohibitive and the measures required remain practicable. “Best practicable means” will vary from site to site, so it may be that the local conditions at some sites will require relatively little action, and much more action may be necessary at others. It makes sense for operators to implement remedial measures in as cost-effective a way as they can and, though such an evaluation is not part of determining “best practicable means”, it is nonetheless likely to be useful in the cost-benefit exercise which Ofwat will want to see.

This Code of Practice describes:

- i. What “baseline” management practices should be adopted, proactively, at all sewage treatment works where there is a material likelihood of causing nuisance due to odour. These practices may be thought of as “housekeeping” measures that would be expected as a matter of course.
- ii. An approach to implementing a further tier of odour abatement above and beyond “baseline” measures, based on the concept of “best practicable means” and a risk-based approach, at those sewage treatment works where odour problems exist or there is risk of odour problems. This specific, stepwise procedure is referred to as the Good Practice Approach.

## **7.2 The application of odour control measures at sewage treatment works**

### **Baseline measures applicable to all sewage treatment works**

Some odour control measures should be put in place by the sewage treatment works operator as a matter of course, to reduce the risk of nuisance occurring in the first place\*. These proactive odour control measures are essentially preventative, and should be thought of as minimum day-to-day operating standards – housekeeping - to be used by all sewage treatment works operators as part of good management practice and to meet their statutory obligations.

Examples are: planned and routine maintenance of plant and equipment; and locating or re-locating sources of odour as far as is practicable from the site boundary and sensitive receptors.

### **Enhanced odour control measures for sewage treatment works experiencing odour complaints**

In some cases, the baseline measures may not be enough on their own to avoid statutory odour nuisance. Other, further measures to prevent, reduce or control statutory nuisance will need to be put in place by the sewage treatment works operator#. The operator may be able to anticipate the need for such measures, but in most cases action will be predicated by complaints assessed as being indicative of a significant odour problem at the sewage treatment works (see Section 6.2). Further measures might include:

- further housekeeping, process and/or operational improvements over and above those described in Chapter 8;
- total enclosure;
- covers for tanks; and/or
- the use of enclosure and venting (including ventilated buildings) - if necessary with end-of-pipe treatment (i.e. dilute/disperse or abatement) - for certain plant and equipment.

There is no simple “one-size fits all” solution to odour problems, and this Code of Practice can make no arbitrary definition of what odour control measures will satisfy the “best practicable means” criterion” (which in any case is not for this Code but for the Courts to determine on a case-by-case basis), or what will be suitable under all circumstances. It is up to the operator ultimately to demonstrate that he is using “best practicable means” in any particular case and for the Court to decide whether or not it agrees if asked to decide the issue (in the event of

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\* Enforcement action on the grounds of statutory nuisance can be taken pre-emptively if a local authority Environmental Health Officer is satisfied that a nuisance is likely to occur.

# Further, enhanced measures (Chapter 9) will only be needed if the site is creating or likely to create a statutory odour nuisance. If the STW is remote from receptors there are unlikely to be complaints or nuisance and further work is unlikely to be needed, even if the works is generating odour.

prosecution). “Best practicable means” takes into account financial considerations so that the measures required are practicable. The concept of “best practicable means” does not involve any weighing of relative benefits. This concept is different, for example, to the current periodic price determination review process, whereby Ofwat requires that regulated sewerage companies plan additional expenditure that might affect prices charged to customers through systematic and consistent assessment of costs and benefits. Industry may decide to issue its own guidance on what it considers appropriate means of control in the generality of cases, but that should not be taken as a defence against statutory nuisance in any particular case. It is up to the Court to decide whether measures taken by an operator in any particular situation are or are not “best practicable means”.

Often there is a combination of measures that go towards resolution of the problem. These can range from very simple (and often very inexpensive) measures, up to very complex (and often costly) measures. Therefore, it is important that a timely, realistic, cost-effective and proportionate approach should be taken to resolve odour issues. There is a need to ensure that the most cost-effective measures or combination of measures are investigated and determined for a range of possible degrees of odour abatement.

Chapter 9 of this Code of Practice specifies the Good Practice Approach that should be used by the sewage treatment works operator for dealing with odour problems in response to complaints of nuisance. It is not possible to specify to the sewage treatment works operator what odour control measures will satisfy the “best practicable means” criterion to solve a particular odour problem. Instead this chapter lays down a procedure for making that choice. It is for the sewage treatment works operator to decide on what means of odour control to use and to be able to justify them to the court in terms of “best practicable means” if prosecuted.

It is not within the scope of this Code of Practice to provide guidance on carrying out cost-benefit assessment. Although this is a well established technique, the application to odour nuisance is not common enough for detailed guidance to be given. To be useful in the context of price regulation (see section 3), the cost-benefit assessment needs to expose the social and environmental value of a range of sustainable solutions, so that potentially optimal “best practicable means” can be anticipated.

Some sewage treatment works operators have found it convenient to group reactive means of odour control into two bands: a first basic set of actions that can be triggered quickly and inexpensively immediately following the complaint, and a second level of more extensive measures that can be employed if the basic actions are not successful in dealing with the problem (e.g. stemming the complaints). This may include, for example, modifying the process or introducing abatement procedures. Operators have also found it useful to implement measures in stages, with the most cost-effective (as measured against abatement of odour emissions) components done first, followed by careful evaluation of the effects. This process allows subsequent stages to be revaluated, and the proposals more accurately matched to need. This Code of Practice encourages such tiered and staged approaches where they can solve the problem and are

practicable. Temporary or partial alleviation is valuable during further work or investigations, provided the Good Practice Approach in Chapter 9 is not bypassed. Where such rapid-response or staged solutions are used, the operator should document clearly the risks and triggers involved in the action, including:

- the criteria for successful resolution;
- when the next step in odour control measures is taken; and
- the basis for such a decision.

Sewerage companies are subject to regulatory price limits which result in competing demands for investment to enhance and maintain service to customers and the environment, including in odour measures at its different sewage treatment works sites. Companies should therefore use a documented prioritisation process to ensure those sites with the greatest odour problems are targeted first. The prioritisation methodology should take into account the number and severity of complaints at the different sewage treatment works. This should not be taken to mean that sites further down a priority list are exempt from the requirements of this Code of Practice on odour nuisance: this Code of Practice is intended to, and the statutory nuisance regime does, apply to *all* sewage treatment works that are not covered by Integrated Pollution Prevention and Control. The concept of “best practicable means” is not defined by the regional priorities of a particular operator, but the prioritisation process, if founded upon robust cost-benefit assessment, will inform the consideration of different sites within an area by the operator and its regulator, Ofwat.

The operator should follow the Good Practice Approach to deal with any complaints as described in Section 9.2. It should be noted that Step 8 requires the operator to implement the measures “*as quickly as is reasonably practicable*”<sup>\*</sup>. The latter will take into account, on a site-by-site basis, the priority list and any financial restrictions. By following the Good Practice Approach, the sewage treatment works operator is satisfying the Code of Practice.

Note, however, that if a statutory nuisance is found to exist, or to be likely to occur or recur, and an abatement order is issued against the works, then the operator is required to implement the measures according to the conditions set out in the abatement notice. This requirement becomes a statutory duty, and breaching or failing to comply with an abatement notice without reasonable excuse is an offence, punishable on conviction through the Court by a maximum fine of £20,000 for statutory nuisances on industrial, trade or business premises.

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<sup>\*</sup> The phrase should not, however, be used as an invitation to prolong indefinitely the implementation of the measures.

## **8. Avoiding nuisance – baseline site management/ practice applying to all sewage treatment works**

### **8.1 General**

There are some means of odour control that should be put in place proactively at all sewage treatment works as a matter of good practice to minimise the risk of odour nuisance occurring.

The basic means of odour control that are expected at all sewage treatment works, include:

- where a choice in location of major sources is practicable, they should be located at positions on the site that are likely to minimise the odour impact on sensitive receptors (see Section 8.3 for further clarification);
- good housekeeping and raw material handling practices;
- control and minimisation of odours from residual materials and waste;
- maintaining the effluent aeration other than in processes which are specifically anaerobic;
- avoiding anaerobic conditions;
- minimising septicity;
- selecting process steps that present least risk of odour.

When developing new and significantly upgraded sewage treatment works, there is the opportunity to review other aspects that can be incorporated into a new build. These include:

- location of major sources away from sensitive receptors at the design stage;
- design and operation of the process steps to minimise odour, including:
- minimisation of sludge retention time in primary settlement;
- applying extended aeration to avoid primary settlement;
- for new and upgraded sewage treatment works, cover (or allow for covering at a later stage where odour effects are difficult to quantify prior to commissioning).

Other odour abatement techniques that should be put in place at all sewage treatment works are described in Sections 8.3 to 8.5.

Lack of attention to plant operation and maintenance is likely to severely weaken a “best practicable means” defence in the event of an appeal (see section 3).

There may be circumstances where having adopted appropriate site management procedures, the process is still giving rise to odour nuisance. In this case, the operator should put in place additional means of odour control according to the Good Practice Approach described in Chapter 9. For example, it may be

necessary to contain strong odour sources or enclose and vent treatment using odour control equipment. In other cases it may be possible that the treatment process can meet the aim without the use of containment, or enclosure with end-of-pipe treatment. It may be possible to reduce odours by careful process evaluation and changing, for example, the process operation and configuration. Reducing the propensity of the sewerage system to deliver sewage that is likely to give high odour emissions when being treated should not be discounted. Septicity is a major contributor to odour, and also poses a severe health risk to health and safety, especially if existing works are covered and contained. Such retro-fitting imposes difficult operational and durability conditions on facilities designed to be open to the atmosphere.

However, in cases where the basic good housekeeping and operational controls (see below) and the management of the sewerage system cannot avoid odour nuisance, the containment, or enclosure and treatment, of odorous emissions is likely to be the key to effective control. Many of the latter techniques when “retro-fitted” are expensive and make the sewage treatment works more difficult to operate. A staged approach is recommended where practicable to allow these techniques to be implemented on the most cost-beneficial elements (in terms of odour abatement) of the works and the results evaluated before judging whether the less cost-beneficial elements (in terms of odour abatement) should be implemented.

## **8.2 Good housekeeping**

Lack of good housekeeping can result in elevated levels of residual odour, and at times more serious emissions of odour. Basic housekeeping measures are listed below. The majority of good housekeeping is, in any case, simply good basic working practice.

### **Location of odour sources**

Where a choice in location of potentially significant odour sources is practicable, they should be located at positions on the site that are likely to minimise the odour impact on sensitive receptors. For fixed-position sources (e.g. major processes or major items of plant) it is only practicable to take account of sensitive receptors present at the time of the plant/process design and build. However, non-fixed odour sources should be sited as far away as practicable from sensitive receptors, even if those receptors were not present at the sewage treatment works design and build stage.

Account should be taken of distance, prevailing wind direction and obstructions. In practice, this will often mean locating sources of odour as far as is practicable from the site boundary.



## **Tanks**

The build up of scum or foam on tank surfaces can at times lead to odour and should generally be avoided\*.

Draining tanks for cleaning has been implicated as a source of odour complaints. Where this is a planned activity, it should be scheduled to minimise impact. Where practicable, appropriate chemicals should be used to minimise odour impact#. Where draining of tanks is because of a process failure, the drive will be to get it back on line as soon as practicable, and so prevent other parts of the process and plant becoming overloaded and causing odour problems.

## **Storage of sludge**

Storage of sludge products on site should be minimised, particularly if unplanned. Treated (i.e. digested or dried) sludge has little odour, but untreated sludge is highly likely to cause odour releases if stored uncovered.

## **Storage of screenings and grit**

Skips containing screenings and grit should be covered and removed from site as soon as is practicable.

## **Spillages**

Spillages should be avoided wherever possible. Spillages are usually due to plant failure. Often, spillages involve sludge: an interruption to continuous sludge processing could lead to spillage from a storage tank or cause sludge levels to build up in settlement tanks, one of the known risk factors for odour at sewage treatment works.

## **8.3 Plant performance, maintenance, inspection and operator training**

Defra research has shown that some odour problems at sewage treatment works have been due, wholly or partially, to problems with plant maintenance and proper operation of odour abatement. These problems were said to be due partly to difficulties in operation, lack of training and poor after-sales service. Plant performance, maintenance, inspection and operator training are therefore crucial in maintaining the effectiveness of odour controls. The measures listed below should be considered.

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\* However, a stable scum layer can reduce odour in some instances, e.g. sludge storage.

# When chemical dosing is to be used, the risk of causing pollution must be given due consideration.

## **Plant performance**

Operators should ensure the good performance of all plants, both the main treatment processes and odour control equipment. This Code of Practice encourages the use of Odour Management Plans (see the *Local Authority Guide on Odour Nuisance from Sewage Treatment Works*<sup>4</sup> for further information on Odour Management Plans) to help to raise the priority given to operating and maintaining abatement systems.

## **Odour Management Plans**

An Odour Management Plan should be prepared for a site, where the operator believes that there is a significant risk of odourous emissions. An Odour Management Plan is a document that is intended to detail operational and control measures appropriate to management and control of odour at the site. The format of the Odour Management Plan should provide sufficient detail to allow operators and maintenance staff to understand clearly the operational procedures for both normal and abnormal conditions. The Odour Management Plan should also include sufficient feedback data to allow site management (and local authority inspectors) to audit site operations. Examples of relevant issues include:

- a summary of the site, waste water treatment works, odour sources and the location of receptors;
- details of the site management responsibilities and procedures for reporting faults, identifying maintenance needs, replenishing consumables complaints procedure;
- odour-critical plant operation and management procedures (e.g. correct use of plant, process, materials; checks on plant performance, maintenance and inspection);
- operative training;
- maintenance and inspection of plant (both routine and emergency response);
- spillage management procedures;
- record keeping – format, responsibility for completion and location of records;
- emergency breakdown and incident response planning including responsibilities and mechanisms for liaison with the local authority.

The Odour Management Plan is a living document and should be regularly reviewed and upgraded.

Operators should regularly undertake screening assessments of plant operations for problems (including odours) on a very regular basis, even in the absence of complaints.

## **Reagents and consumables**

Adequate supplies of reagents and consumables should be kept on site, always subject to the practicability of shelf life and providing the appropriate storage conditions. Records should be kept of the delivery and usage of all chemicals and reagents, and these records should be used to minimise the risk of running out. Schedules should be prepared for the planned replacement of longer-lasting reagents such as activated carbon, dry scrubbing chemicals or bio-filter media, together with any monitoring which has a bearing on the suitability of these plans.

## **Planned inspection and maintenance**

An effective, planned inspection and preventative maintenance regime should be employed on all odour-critical plant and equipment identified (in, for example, the Odour Management Plan) as impacting on odour. Important points are:

- a written maintenance programme should be included in the Odour Response Procedure (see below);
- a record of maintenance should be made available for inspection if required;
- all external pipework used for scrubbing liquor, condensate, steam, cleaning water, irrigation water and process liquid transfer should be leak-proof.

Operators should also seek to allow Environmental Health Practitioners access to sites and information during the course of investigations into statutory nuisance.

## **Emergency breakdown response**

The operator should prepare an Odour Response Procedure for each piece of odour-critical system or plant, documenting the response for emergency breakdown. This should include the foreseeable situations that may compromise his ability to prevent and/or minimise odorous releases from the process and the actions to be taken to minimise the impact. It is intended to be used by operational staff on a day-to-day basis and should detail the person responsible for initiating the action.

The Odour Response Procedure for the odour-critical system or plant should state whether there is a stand-by or back-up system or plant, or whether reliance is to be placed on repair in the event of breakdown. If the latter, the procedure should include a list of essential spares: where practicable, spares should be held for items liable to fail on odour-critical plant. The equipment manufacturer should recommend which spares are subject to wear and foreseeable failure and are critical for the correct operation of the odour abatement equipment (such as pumps, some types of adsorption media, nozzles, etc.) and these should be held on site. It may be acceptable for certain spares to be available on guaranteed short delivery if the absence of a supply at the site would not lead to complete failure of the odour control equipment or to odour nuisance.

The Odour Response Procedures should also deal with the possibility of unusual or extreme conditions that could potentially affect odour impacts on the surrounding community. Some of these conditions may be associated with environmental factors, such as heavy rainfall requiring the filling of storm tanks or extremely stable atmospheric conditions associated with low wind speed (resulting in low dispersion and low dilution of odours). Other extreme conditions might be due to problems with the wastewater treatment process itself. Operator errors resulting in improper plant operation or unexpected operating conditions should be considered and plans put into place to quickly re-establish control of the process and minimise the impact of odours. These sort of extreme conditions can be anticipated and should be expected and planned for.

The Odour Response Procedure should be reviewed regularly and revised taking into account any lessons learned from odour incidents.

### **Competence and training**

Staff at all levels with duties related to the management, operation, maintenance or repair of odour-critical processes and plant should be trained and competent and have documented training records. In order to minimise risk of odour emissions, particular emphasis should be given to control procedures during start-up, shut down and abnormal conditions. This Code of Practice encourages training to be addressed as part of an Environmental Management System (EMS). The operator should maintain a statement of training requirements for each operational post and keep a record of the training received by each person whose actions may have an impact on the environment. Training should include:

- awareness of their responsibilities for avoiding odour nuisance;
- minimising emissions on start up and shut down;
- action to minimise emissions during abnormal conditions.

## **8.4 Odour complaints action procedure for sewage treatment works operators**

Complaints are a very important indicator (although not the only one) of nuisance and other community dissatisfaction. There are many reasons why people annoyed by odours might not complain, for the reasons explained in Section 6.3. For this method of assessment to be effective, barriers to complaints should be minimised wherever possible. It is important that complaints are properly and systematically dealt with and acted upon.

The sewage treatment works operator should have in place a procedure specifying how any complaints of odour from the works will be administered and progressed, from receipt of complaint, through initial screening and validation, to action/response. The odour complaints action procedure should show who is responsible for dealing with the different aspects of the complaint, and what is being done about complaints. For example:

- to whom in the company/site are complaints to be directed to as a point of central contact;
- who in the company/site has management responsibility for ensuring complaints are assessed and dealt with;
- who in the company/site has technical responsibility for dealing with the resolution of any complaints where assessed as significant;
- who in the company/site is responsible for liaison with the local authority on progress (from acknowledgement of complaint to resolution where assessed as significant);
- who in the company/site is responsible for liaison with the local stakeholders on progress (from acknowledgement of complaint to resolution where assessed as significant);
- what complaints have been made and what action is being taken to identify and, where appropriate, mitigate the cause;
- how dialogues will be engaged in where significant schemes are involve;
- how and to whom the operator knowledge bank will be disseminated.

## **9. Enhanced odour control measures**

### **9.1 The general approach to resolving odour complaints**

This chapter describes the procedure that should be followed if an odour nuisance (i.e. the odour is deemed as having an unacceptable impact as described in Chapter 5) is still being caused once the proactive baseline measures in Chapter 8 have been implemented.

There is no single, absolute, technical fix that can be applied to all the different causes of odours from sewage treatment works. Where it is not possible to prevent the nuisance, there are many different means of controlling or abating the nuisance. It is up to the operator to demonstrate that he is using “best practicable means” in any particular case (particularly upon appeal when it becomes a means of defence), and that he has used a suitable methodology that takes into account both practicability and finance.

It is possible, however, to follow an agreed plan of action that starts with the receipt of a complaint and ends with the resolution of the problem.

The plan of action should allow all stakeholders to see that the choice of abatement and control measures proposed for a specific site has been arrived at in a way that is technically justifiable and otherwise practicable, including with regard to financial implications. All stakeholders should be able to have confidence that the option chosen is appropriate to resolve the problem, but with protection against over specification. Techniques for choosing degrees of abatement and control are covered in more detail in section 9.2, Step 6, but should be consistent with the description of the “best practicable means” defence described in section 79 (9) of the Environmental Protection Act 1990 as:

- reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;
- the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures;
- compatibility with any duty imposed by law; and
- compatibility with safety and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances.

It is for the sewage treatment works operator to decide on what means of odour control to use, and to be able to justify them in terms of “best practicable means”. It should be emphasised that adherence to this Code of Practice will not necessarily result in zero odours around the sewage treatment works. Having regard to the financial implications indicates that there will be a limit to nuisance minimisation or degree of odour abatement beyond which the costs can be deemed as too great, and this limit might include ongoing impact on the costs of operating and maintaining the works. The Good Practice Approach allows for this possibility. In the event that the operator comes to this decision, a robust cost benefit assessment should be made available to support the conclusion, bearing in mind, however, that ultimately it is for the Court to decide if this decision is the right one or not, or demonstrates the appropriate principles, in the case of a prosecution.

### **The Good Practice Approach**

The Good Practice Approach for resolving odour nuisance complaints at sewage treatment works is summarised in the flow chart in Figure 1. Sometimes the problem may be quite simple to deal with, some of the steps will be obvious, and the whole process through to resolution may be fairly intuitive. At other times, the problem may be more complex and the step-wise approach can help clarify for all stakeholders the route through to resolution. The operator should document the decisions and findings of each stage so as to be able to justify the measures chosen to resolve the odour nuisance.

The Good Practice Approach is a step-wise process. But not all complaints will necessarily require all the nine steps. Sometimes the step-wise process will stop at, say, Step 2 or Step 7.

All the steps in the Good Practice Approach are relevant to the sewage treatment works operator in dealing with the odour nuisance. Some steps – particularly Step 1, Step 2 and sometimes Step 9 – are also relevant to the local authority Environmental Health Practitioner in his regulatory and enforcement role.

A range of different techniques or “tools” can be used at each of the steps. The application of the particular tool or technique is mentioned briefly in Section 9.2. Usually there will be several options, each of which may be appropriate in some

situations and not in others. The sewage treatment works operator will need to use the most appropriate means for the application, and be able to justify the choice.

### **Proportionality**

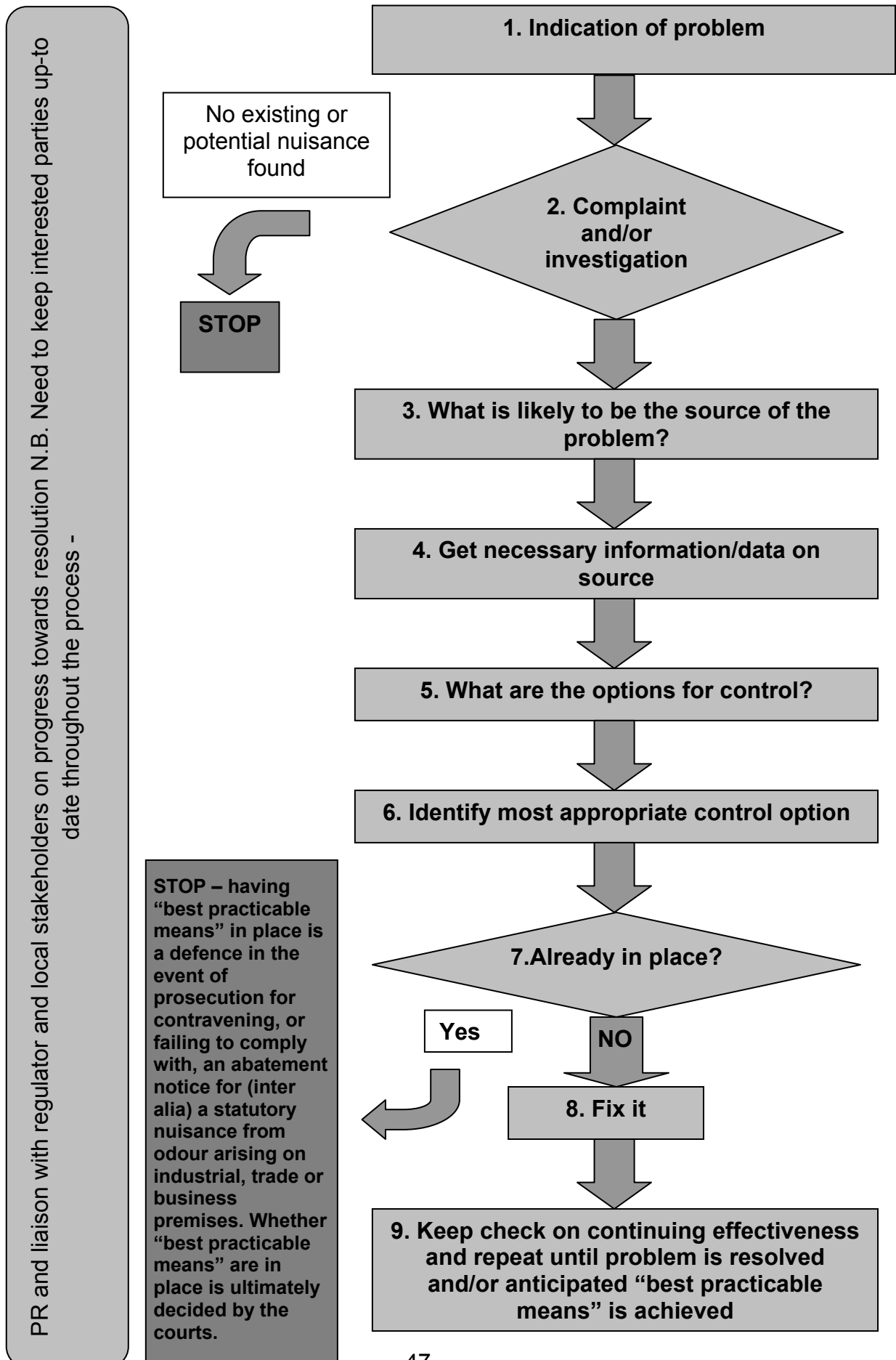
The amount of resources needed for each step will vary according to the complexity of the problem and the scale of the costs for the likely abatement or control measures. The response should be proportionate: sufficient to select the right measures to improve or abate the odour problem, but without making the process unduly lengthy, or complex.

It is important not to confuse levels of effort and expense with effectiveness. If a particular level of odour may not justify a major redesign of a treatment plant involving millions of pounds of investment, that should never be used as an excuse for not employing other odour control measures. All appropriate measures should be creatively and thoughtfully applied within practicable limits and with a view to their commercial viability. The most obvious and expensive odour control technologies may not even be the most effective.

### **Anticipating odour problems**

Although regulation under the statutory nuisance regime is in practice largely (though not entirely) reactive, sewage treatment works operators should so far as is reasonably practicable anticipate potential odour problems rather than only deal with odours after they have occurred. Preventing odours can be much more cost effective than solving them later.

**Figure 1. The Good Practice Approach for Dealing with Odour Nuisance at Sewage Treatment Works**





## **9.2 The steps in the Good Practice Approach**

### **Step 1 – Complaint received**

Whenever the sewage treatment works operator or local authority Environmental Health Practitioner receives odour complaints, the other party should be informed and the necessary details shared - within the limits of confidentiality policies and requests, and data protection procedures. Acknowledgement should be provided to the complainant that the complaint has been received and is being dealt with and how. The investigating Environmental Health Practitioner may also inform the local Consumer Council for Water that he has received a complaint in order that the Council can provide any evidence of previous odour complaints or nuisance. However, the Consumer Council for Water focuses on the public as consumers rather than the impact of sewage treatment works on the public, and its regional offices may not record evidence of complaints or nuisance.

The sewage treatment works operator should deal with any complaints received according to its Complaints Action Procedure (see Section 8.2).

The Environmental Health Practitioner should deal with any complaints received according to the local authority's own Complaints Action Procedure (Section 6.3).

There should be regular communication and liaison between the local authority, operator, regulator, complainants and other stakeholders on progress towards a resolution.

### **Step 2 – Assessment of complaints**

The odour complaint should be considered in conjunction with other relevant complaints, and together with any other necessary tools (see Section 5.2.2) to assess whether it is indicative of a statutory nuisance being caused by the sewage treatment works or the likelihood of such occurring in the future. The good practice technique for carrying out this assessment is described in Part II of this Code of Practice, Chapter 6.

The sewage treatment works operator and the Environmental Health Practitioner should both use documented procedures for assessing all complaints to help determine if they indicate a significant odour problem. Their procedures should state clearly the steps and the actions that will be followed, from receipt of a complaint to a decision by the Environmental Health Practitioner on whether or not statutory odour nuisance is being or may be caused. It is important that the complaint assessment procedure is as objective as practicable. Life is easier if the sewage treatment works operator and the Environmental Health Practitioner both come to the same conclusion on whether the complaint indicates a significant odour problem, although it is not realistic always to expect it.

The sewage treatment works operator and the Environmental Health Practitioner should each communicate and liaise with the complainant, each other, and local stakeholders to keep them involved in the process of investigating the complaint, the outcome and what, if any, further action is to be taken.

### **Step 3 – What is the likely source of the problem at the sewage treatment works?**

If the complaints are assessed as being indicative of a statutory odour nuisance being caused by the works, the operator should take necessary steps to identify the source(s) of the odour complaint. Appropriate techniques may include:

- expert knowledge of operator;
- knowledge of plant operation conditions (especially problems) at time of complaint;
- investigations, e.g. engineering and process investigations, walk-through surveys incorporating sniff tests;
- assessing the contribution to the problem of characteristics of the sewerage system;
- measurement and monitoring may be appropriate in some circumstances, usually if the source cannot be identified by any of the preceding techniques or if a high level of certainty is required.

The operator should also consider if the sewage treatment works itself is the root of the problem, or whether the odour at the sewage treatment works is rooted further upstream or in a remote part of sewerage system. This may include local industrial sites discharging into the sewers upstream of the sewage treatment works and the propensity for septicity to occur.

### **Step 4 – Obtain the necessary information on the source**

The sewage treatment works operator should collect such information and data that are necessary to select properly a means to stop or restrict the odour problem. In some cases the means may be obvious and very little information will need to be collected. Other cases will be more complex, requiring more information to tackle the problem successfully. Thus the amount of effort and detail in obtaining this information and data will vary depending on the severity of the problem, and the required certainty for confirming the root source of the problem and deciding what type of odour control measure is appropriate.

Next, the sewage treatment works operator should make a judgement of the contribution the previously identified cause(s) makes to the odour nuisance and how much it could be reduced to abate or control the nuisance. Again this may appear obvious in some cases and one can proceed intuitively based on very little information, for example, for covering some small open tanks, it is not necessary to work out a quantitative value for how much the emissions should be reduced – the assumption is made that the control measure will be close to 100% effective. Other cases, for example, large tanks with options for treating the contained odorous air, or specifying an abatement system with a minimum odour removal efficiency, are more complex or a greater level of certainty is required. Considerably more effort and detail will be used here to assess the impact of the odour release taking into account the pathways to the receptors and the impact of the odour on those receptors.

Table 3 describes some of the quantitative odour assessment tools that can be used if they are needed. For non-quantitative assessments, the main tool is the population survey. The use of multiple assessment tools may help to increase the confidence in conclusions drawn.

**Table 3. Quantitative tools available to provide necessary information on the source**

<b>Tool</b>	<b>Technique</b>	<b>Variants</b>	<b>Comments</b>
<b>Tools for estimating odour source release rates</b>	Estimating odour emission rates from concentrations and flows.	1. Direct measurement of odour concentration (in Odour Units per m <sup>3</sup> ); or 2. Measurement of individual species.	There are advantages and disadvantages to each of these two approaches.
	Estimating odour releases from analyses of bulk materials.	Includes measurement of Odour Potential (OP).	Also often used for investigative purposes.
	Estimating odour releases using mass transfer models.	Includes the STOP model.	
<b>Tools for predicting the magnitude of odour at receptors</b>	Computer Dispersion Modelling.	Range from simple spreadsheets to sophisticated computer models that use real historical meteorological data to predict how many hours per year a specified ground level odour concentration will be exceeded.	Can “back-calculate” from notionally acceptable ground-level odour concentrations to find maximum allowable emission of odour from controlled sources (usually point sources such as stacks/ vents).
	Radius of Effect.	A very simplified form of modelling is to estimate the odour’s radius of effect.	More detailed modelling normally required if nuisance is indicated, but screens out low risk works well.

<b>Tools for assessing the significance of the odour impact at receptors</b>	Comparing predicted or measured concentrations with numerical Air Quality Standards for ambient air.	Two types exist: 1. Odour concentration guidelines for specific compounds ( $\mu\text{g}/\text{m}^3$ ); and 2. Ambient concentration guidelines set in Odour Units ( $\text{ou}_E/\text{m}^3$ )	There is no officially recognised ambient concentration standard set in Odour Units ( $\text{ou}_E/\text{m}^3$ ), although some custom and practice guidelines exist.
	Monitoring odour impact at receptors.	Quantitative monitoring of individual chemical species by either: • Field determination using direct-reading instruments; or • Sampling followed by laboratory analyses	Only monitoring of chemical species is possible. It is not possible to monitor odour directly ( $\text{ou}_E/\text{m}^3$ ) in ambient air, at the receptors or at the site boundary.
		Sniff Test (see Appendix 3 for further details). N.B. This tool is semi-quantitative.	Uses a trained assessor's nose to assess the intensity, persistence and character of odour at a location.
	Odour mapping.	Usually for $\text{H}_2\text{S}$ . Less commonly for ammonia (around processes for the alkali treatment of sewage sludge).	Maps of concentrations measured within and around the sewage treatment works can give a very good indication of the most significant odour sources at a works.

### Step 5 – What are the options for control?

Having now identified the source of the nuisance and by how much the odour might potentially be reduced, the sewage treatment works operator should consider the different options that could be used to control or abate the odour emissions, and, *inter alia*, the nuisance. As a general principle, preventing odour emissions from the effluent stream is preferred to their containment and treatment of the odorous air. Where it is not practicable to prevent the odour emissions from the process stream, options to minimise these emissions should be incorporated into the final solution unless these are clearly not cost-effective, with the aim of reducing emissions to a level that will not cause statutory nuisance. There are a wide range of control measures that can be used, including:

- the general management of the sewage treatment works;
- the design, installation and maintenance of plant, buildings and structures;
- the operation of the sewage treatment works and its processes;
- engineering solutions, e.g. containment, enclosure coupled with venting and end-of-pipe treatment (abatement, and/or disperse and dilute from an elevated stack) of excess air.

Measures that are regarded as being part of normal site operation/management (see sections 7 and 8) may provide big improvements without incurring much (if any) additional cost. The fourth option, an engineering solution, either at the works or within the sewerage system, may be more expensive in whole life cost terms. In most circumstances, operators would wish to consider measures in the context of “best practicable means”, use, cost benefit and cost-effectiveness assessment to find the optimum solution from a range of options. These tools will inform the operator in making the judgement on which solution, or degree of abatement, should be considered “financially reasonable” or commercially viable and proportionate.

The main types of odour abatement techniques currently available can be categorised as shown in Table 4.

**Table 4. The main types of odour abatement**

Type	Technique	
Biological abatement techniques	Bio-filters	
	Bio-scrubbers	
Non-biological abatement techniques	Wet chemical scrubbing	
	Dry chemical scrubbing/ adsorption	
	Oxidation systems	<input type="checkbox"/> Combustion oxidation
		<input type="checkbox"/> Catalytic oxidation
	<input type="checkbox"/> Ionised air oxidation	

Control options are usually considered in the following order of preference before escalating to the next level:

1. Site management and housekeeping \*
2. Operational and process changes
3. Containment
4. Enclosure, coupled with end-of-pipe treatment (abatement, and/or disperse and dilute from an elevated stack) of excess air.

Practical, safety<sup>#</sup> and financial restraints may mean this hierarchy cannot be applied rigidly to every application (see Step 6).

\* A basic level of good practice housekeeping will already have been implemented as part of the basic measures required by Chapter 8.

<sup>#</sup> In some cases, efforts to control odorous emissions could potentially result in unsafe working environments, which should be avoided. This potential conflict must be considered at every stage of design, operation and remediation.

## Step 6 – Identify the suitable option(s) for control

This step, which is partially initiated in step 5, may be straightforward and intuitive for very simple problems, but is likely to involve considerable analysis where the problem is more complex or costly or where the cost penalties of getting the choice wrong could be severe.

Having identified the different control options and degree of abatement that are practicable for this particular problem, the sewage treatment works operator should carry out a robust assessment to choose the optimum measure (or a combination of measures giving a combined optimum solution) to resolve risk of odour nuisance. The aim should be for the operator, so far as he is able<sup>Φ</sup>, to select odour control measure(s) that represent “best practicable means”. Note that it is quite possible that “best practicable means” could be a combination of several measures, none of which is adequate on its own.

As explained previously, “best practicable means” is described at s 79 (9) of the Environmental Protection Act 1990 as:

- reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;
- the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures;
- compatibility with any duty imposed by law; and
- compatibility with safety and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances.

The choice of the most appropriate technique can be complex. Each will have its own advantages and disadvantages in terms of application, performance and cost. It is for the sewage treatment works operator to justify the choice of odour control measures in terms of “best practicable means”. “Best practicable means” takes account of factors including local circumstances and available techniques, but also financial considerations. In addition, operators may in a separate exercise have to justify the cost-benefit of their choices to Ofwat (see sections 3.4, 7.2, 9.1 and step 5) in the context of their broader asset management plans. It is not within the scope of this Code of Practice to provide guidance on carrying out a cost-benefit assessment. Environment Agency guidance<sup>14</sup> on balancing cost versus benefit and options appraisal of different measures at industrial installations may provide useful guidance for this step. Industry and/or Government may decide to develop guidance in the light of further research and experience from the application of this Code.

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<sup>Φ</sup> It is up to the Court to decide whether measures taken by an operator in any particular situation are or are not Best Practicable Means.

To complete step 6, therefore, the operator needs to estimate the cost-effective solutions (in terms of sustainable whole life costs) for a range of possible degrees of odour abatement and control (i.e. odour reduction), and adopt a rational approach to select the optimum option from the different levels of abatement that might satisfy the “best practicable means” test.

Implementation time of the potential control measures is a third important factor and should be considered along with the effectiveness and costs of the solutions. It may be a deciding factor between several options of equal merit in terms of cost-benefit. Additionally, for control solutions with long lead-in times, the implementation of quick solutions having high benefit should be considered as temporary measures.

By following an accepted and transparent method, all stakeholders should be able to have confidence that “best practicable means” has been anticipated and chosen to resolve the problem. Use and development of the established techniques cited offer considerable protection against over specification. Relations and dialogue with complainants and the public, and liaison with regulators and other stakeholders will be very important at this stage.

### **Step 7 – Is the suitable option already in place?**

If the preceding step leads the operator to anticipate that the “best practicable means” are already in place with regard to odour which the Environmental Health Practitioner has determined to be or likely to be a statutory odour nuisance, then it follows that further measures cannot be put in place without being either impractical, unavailable, or excessively costly, or being considered as not meeting the test of reasonableness. The sewage treatment works operator will need to liaise effectively with the local authority Environmental Health Practitioner and local stakeholders if this is the case.

One important point is that what constitutes the appropriate and suitable odour control measure, and the Courts view of what constitutes “best practicable means”, may be a moving target over time and as technologies change. It will depend on what means are available, their effectiveness and their cost *at any given time*.

### **Step 8 – Fixing the problem**

Where the suitable or “best practicable means” measure(s) for controlling the odour problem are *not* already in place, the sewage treatment works operator should advise the regulator and local stakeholders how it will implement the improvement. The sewage treatment works operator should use good project management and planning principles to implement the solution effectively and as quickly as is reasonably practicable. For anything other than very simple, quick measures, this should involve producing a project plan, showing expected progress and actual progress against milestones and goals (e.g. design and specification, procurement, installation, commissioning).

Risks of not achieving the desired outcome should be clearly identified, assessed and where practicable plans made for mitigation. In the event that the means of odour control are put in place and the statutory odour nuisance continues to occur, it will be necessary to go back to Steps 4, 5 or 6 as appropriate and re-evaluate the options. However, this should not be interpreted as a requirement for an endless escalation of measures: it must be emphasised again that adherence to this Code of Practice will not necessarily result in zero odours around a sewage treatment works.

### **Step 9 – Keeping a check on continuing effectiveness**

The sewage treatment works operator should make such checks as are necessary to monitor the continuing effectiveness of the chosen odour abatement and control measures.

More detailed checks and investigations would normally be initiated immediately if any problems were discovered. When a complaint is received, records of assessments of plant operation and odour control should be immediately reviewed. More thorough investigations should be initiated whenever there are any indications of a problem or if multiple complaints are received.

Checks on the continuing effectiveness of control measures should include some or all of the following, with the amount of effort and cost involved depending on the risk (likelihood) and consequences of odour nuisance from the particular sewage treatment works.

#### **A. On-site checks to keep the control measures effective**

##### ***i) Procedural and management systems***

- ◆ **Odour Management Plan** – this formalises odour-critical management procedures, operative training, and operational procedures (e.g. correct use of plant/process/materials; checks on plant performance, maintenance and inspection).
- ◆ **Maintenance, inspection and plant operator training** – these are crucial in maintaining the effectiveness of odour control measures and are already covered under Section 8.4.

##### ***ii) Technical measures***

- ◆ **Monitoring of source emissions of odour or a surrogate** – for controlled odour emissions (e.g. from stacks, vents, ducts and odour abatement plant) monitoring of the source emissions (or a surrogate quantity, e.g. H<sub>2</sub>S) can be carried out. Monitoring may be periodic (e.g. annually to check odour abatement efficiency) or continuous to give an instantaneous indication of performance. The latter may be linked to an alarm to give an audible or visual warning of unacceptable emission levels.



## **B. Checks beyond the site boundary**

### ***i) Procedural and management systems***

- ◆ **Complaints monitoring** - the monitoring of the level of complaints from surrounding sensitive receptors is an important method of checking the effectiveness or otherwise of measures implemented to reduce nuisance due to odour. Refer to Chapter 6. Complaints may have been made either to the operator of the sewage treatment works or direct to other bodies such as the local authority environmental health department or the local Consumer Council for Water committee.

### ***ii) Technical measures***

- ◆ **Monitoring of odour at the boundary-fence/perimeter line** – monitoring can range from straightforward and inexpensive “sniff” tests to complex quantitative measurements (e.g. sampling and analysis of specific odorous compounds, such as H<sub>2</sub>S). The technique used should be fit for purpose to demonstrate continuing effectiveness of the control measure. The “sniff” test is probably the most common technique for assessing the (continuing) effectiveness of odour control measures. It should, however, be regarded as only semi-quantitative even when the subjective factors have been minimised by the use of a trained assessor following a documented protocol.

### ***iii) Population surveys, odour logs and odour diaries***

- ◆ Such tools can be used to help monitor and maintain the effectiveness of abatement measures. Surveys conducted by market research would be too expensive for continuing application. Odour logs and diaries are more appropriate in this case.

The sewage treatment works operator should have in place procedures to ensure feedback of the findings of checks on the effectiveness of odour control, so that appropriate actions can be taken in response to problems. Continuing effectiveness of odour control should be a standing item on the agenda of relevant management meetings.

The sewage treatment works operator should ensure there is liaison with the local authority Environmental Health Practitioner and local stakeholders on the continuing effectiveness of the control measures and any problems that have been encountered or expected.

## 10 Glossary of terms

<b>Acceptability criterion</b>	A level of exposure (of sensitive receptors) which, according to current understanding, is acceptable to the majority of the population. These criteria are expressed in terms of a number of odour units as a percentile of a year of hourly means and are based upon dose effect studies undertaken around a number of odour-emitting industry types. The term “odour exposure criterion” has the same meaning.
<b>Analytical assessment</b>	An assessment of an odorous sampling using instrumentation to provide information on the concentration and possibly provide identification of the chemical species present. Compare with “sensory” assessment.
<b>Anosmia</b>	Lack of sensitivity to olfactory stimuli – unable to detect odours at all (compare with hyposmia).
<b>Area source</b>	A surface-emitting source, which can be solid (for example the spreading of wastes, material stockpiles, surface of a biofilter) or liquid (storage lagoons, effluent treatment plant).
<b>“Best practicable means” or BPM</b>	<p>Section 79(9) of the Environmental Protection Act 1990 provides that it is a defence against Statutory Nuisance action to prove that “best practicable means” have been used to control and mitigate the nuisance. The key parts of the term can be defined as:</p> <p>“<i>practicable</i>” means reasonably practicable having regard amongst other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;</p> <p>the “<i>means</i>” to be employed include the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures.</p>
<b>CEN Olfactometry Standard</b>	BS EN 13725: 2003, Air Quality – Determination of Odour Concentration by Dynamic Olfactometry.
<b>Detection threshold</b>	The point at which an increasing concentration of an odour sample becomes strong enough to produce a first sensation of odour in 50% of the people to whom the sample is presented. This is a laboratory-based test and should be conducted according to the relevant CEN standard. The odour concentration at the detection threshold is one odour unit.
<b>Diffuse sources</b>	Sources with defined dimensions (mostly surface sources) that do not have a defined waste air flow, such as waste dumps, lagoons, fields after manure spreading, un-aerated compost piles.
<b>Exposure</b>	Concentration x duration x frequency of the odour to which a receptor is exposed.

<b>Dilution factor</b>	The dilution factor is the ratio between flow or volume after dilution and the flow or volume of the odorous gas.
<b>Fugitive releases</b>	Unintentional emissions from e.g. flanges, valves, doors, windows – that is, points which are not designated or intended as release points.
<b>Diffuse sources</b>	Sources with defined dimensions (mostly surface sources) which do not have a defined waste air flow, such as waste dumps, lagoons, fields after manure spreading, un-aerated compost piles.
<b>Dilution factor</b>	The dilution factor is the ratio between flow or volume after dilution and the flow or volume of the odorous gas.
<b>Emission factor</b>	The emission per unit product (e.g. for wastewater treatment works expressed in this report the emission rate in $ou_E \cdot s^{-1}$ per kg BOD, in screened sewage).
<b>European odour unit, <math>ou_E m^{-3}</math></b>	That amount of odorant(s) that, when evaporated into 1 cubic metre of neutral gas at standard conditions, elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM), evaporated in one cubic metre of neutral gas at standard conditions.
<b>European Reference Odour Mass (EROM)</b>	The accepted reference value for the European odour unit, equal to a defined mass of a certified reference material. One EROM is equivalent to 123 $\mu g$ n-butanol (CAS 71-36-3). Evaporated 1 cubic metre of neutral gas this produces a concentration of 0,040 $\mu mol/mol$ .
<b>Hedonic tone</b>	A judgement of the relative pleasantness or unpleasantness of an odour made by assessors in an odour panel. A methodology is described in VDI 2882. (Compare with “offensiveness”). Odours which are more offensive will have a negative hedonic score whilst less offensive will tend towards a positive score. Hedonic scores are listed in Part 1 of this Guidance Note.
<b>Hedonic scale</b>	A judgement of the relative pleasantness or unpleasantness of an odour made by assessors in an odour panel. A methodology is described in BDI 2882. Odours which are more offensive will have a negative hedonic score whilst less offensive will tend towards a positive score.
<b>Hyposmia</b>	Partial inability to detect odours (compare with anosmia).
<b>Odorant</b>	A substance which stimulates a human olfactory system so that an odour is perceived.

<b>Odorant flow rate</b>	<p>The odorant flow rate is the quantity of odorous substances passing through a defined area at each time unit. It is the product of the odour concentration <math>c_{od}</math> and the outlet velocity <math>v</math> and the outlet area <math>A</math> or the product of the odour concentration <math>c_{od}</math> and the pertinent volume flow rate <math>V</math>, in e.g. <math>m^3/h</math>. Its unit is <math>ou_E/h</math> (or <math>ou_E/min</math> or <math>ou_E/s</math>, respectively).</p> <p><i>Note: The odorant (emission) flow rate is the quantity equivalent to the emission mass or volume flow rate, for example in dispersion models.</i></p>
<b>Odour abatement (efficiency)</b>	<p>The reduction of the odour concentration or the odorant flow rate due to an abatement technique, expressed as a fraction (or percentage) of the odour concentration in the odorant flow rate of the untreated gas stream.</p>
<b>Odour concentration</b>	<p>The amount of odour present in cubic metre of sample gas at standard conditions. The odour concentration is measured in European odour units (<math>ou_E m^{-3}</math>). The odour concentration at the detection threshold is defined to be <math>1 ou_E m^{-3}</math>. If an odour sample has been diluted in an olfactometer by a factor of 10,000 to reach the detection threshold, then the concentration of the original sample is 10,000 odour units.</p>
<b>Odour detection</b>	<p>To become aware of the sensation resulting from adequate stimulation of the olfactory system.</p>
<b>Odour sensitive receptor</b>	<p>The closest fixed building or installation where odour annoyance may occur, such as residential homes, school, hospital, overnight facility for holidays etc.</p> <p><i>Note: The odour concentration is not a linear measure for the intensity of an odour. Steven's Law describes the a-linear relation between odour stimulus and its perceived intensity. When using odour concentrations in dispersion modelling, the issue is complicated by the effects of the averaging time of the dispersion model, further complicating the use of the odour concentration as a direct measure for dose. To define a 'no nuisance level', the entire method of dosage evaluation, including the dispersion model, will yield a 'dose'. The relation between this 'dose' and its effect (odour annoyance) should be validated in practical situations to be a useful predictive too for occurrence of odour nuisance.</i></p>
<b>Odour unit</b>	<p>The amount of odorant(s) that, when evaporated into 1 cubic metre of neutral gas at standard conditions, elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM), evaporated in one cubic metre of neutral gas as standard conditions.</p>

<b>Offensiveness</b>	An expression of the degree of unpleasantness of one odour relative to another. The perceived offensiveness of an odour will vary between individuals as a result of both physical and psychosocial differences, but in a population a relatively consistent response on the relative offensiveness of different odours is returned.
<b>Olfactometer</b>	Apparatus in which a sample of odorous gas is diluted with neutral gas in a defined way and presented to an odour panel under reproducible conditions.
<b>Olfactometry</b>	Measurement of the response of assessors to olfactory stimuli. (ISO 5492).
<b>Olfactory</b>	Pertaining to the sense of smell (ISO 5492).
<b>Olfactory receptor</b>	Specific part of the olfactory system which responds to an odorant (after ISO 5492).
<b>Olfactory stimulus</b>	That which can excite an olfactory receptor (ISO 5492, modified).
<b>Panel member</b>	An assessor who is qualified to judge samples of odorous gas, using olfactometry within the scope of CEN Olfactometry standard (Reference 11). An assessor has to fall within defined limits of sensitivity as set out in the CEN standard.
<b>Point source</b>	An intentional point of release such as a vent or chimney, where it may be possible to obtain a sample in order to quantify the concentration and determine the mass release rate.
<b>ppb</b>	Parts per billion.
<b>ppm</b>	Parts per million.
<b>Recognition threshold</b>	The odour concentration which has the probability of 0.5 of being <u>recognised</u> under the conditions of the test. The recognition threshold is generally a higher concentration than the detection threshold. It is generally two or three odour units in a laboratory setting but may be higher than this outside the lab.
<b>Sample</b>	The odorous gas sample which is assumed to be representative of the gas mass or gas flow under investigation, and which is examined to determine the odour concentrations, to characterise the odour or to identify constituent compounds.
<b>Sensitive receptor</b>	People who are exposed to odour released from a given source, or have the potential to be exposed. Unlike other pollutants, odour at environmental exposure levels is not considered in terms of possible detrimental effects on animals and plants.
<b>Sensory</b>	Relating to the human response to a particular stimulus (in this case, odour). Compare with 'analytical' methods of assessment.
<b>Sensory fatigue</b>	Form of adaptation in which a decrease in sensitivity occurs (ISO 5492).

<b>To smell</b>	To detect or to attempt to detect an odorant.
<b>Specific emission rate</b>	The emission rate per unit of area of liquid or solid.
<b>Volatile organic compound</b>	Organic substance that will readily evaporate and transfer from a liquid into a gas phase.

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