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.

[*] 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*[4] 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

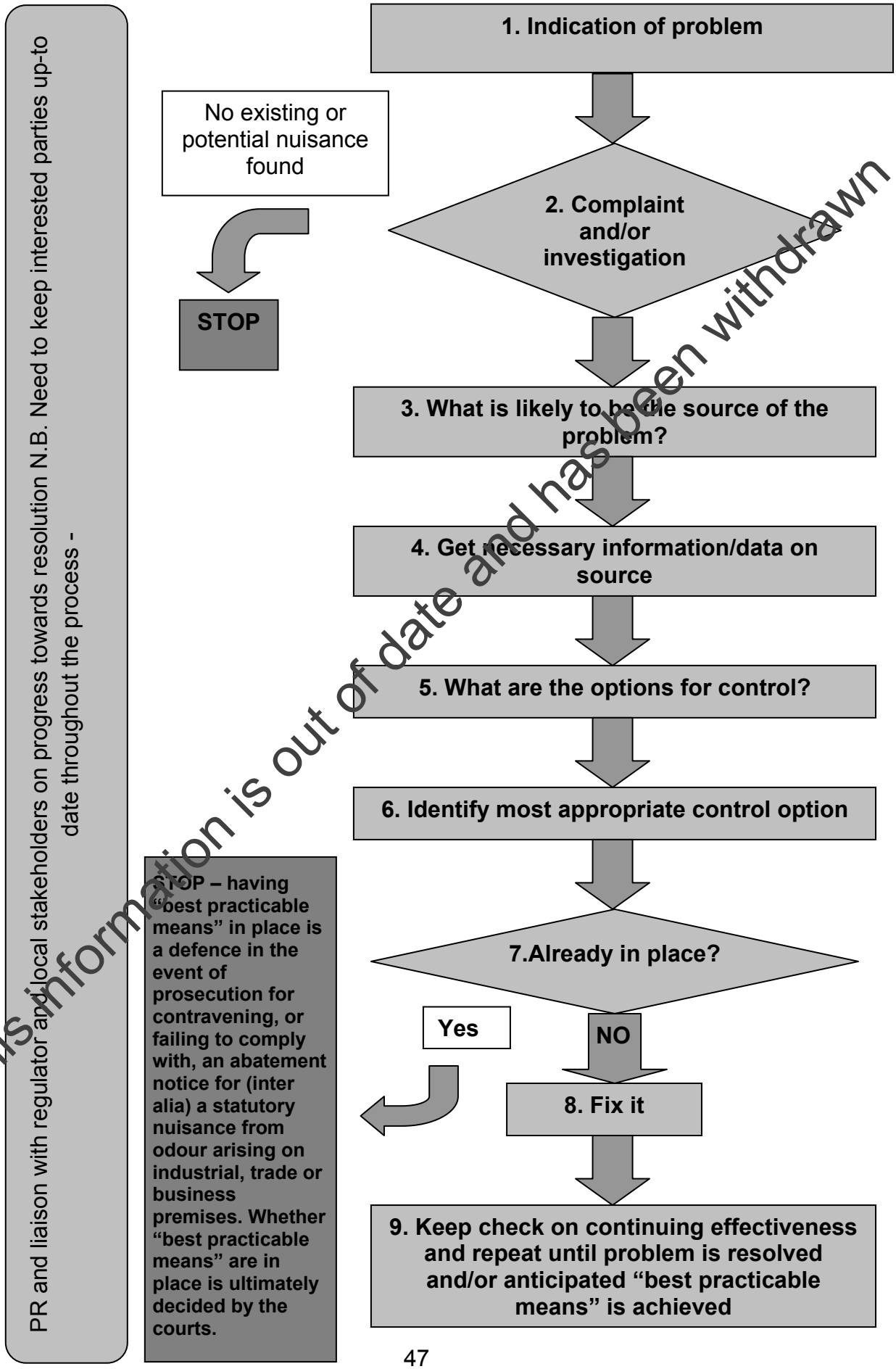
The amount of resources needed for each step will vary according to the complexity of the problem and the scale of the costs for the likely abatement or control measures. The response should be proportionate: sufficient to select the right measures to improve or abate the odour problem, but without making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

Tool	Technique	Variants	Comments
Tools for estimating odour source release rates	Estimating odour emission rates from concentrations and flows.	1. Direct measurement of odour concentration (in Odour Units per m^3); 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.	
Tools for predicting the magnitude of odour at receptors	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.

Tools for assessing the significance of the odour impact at receptors	Comparing predicted or measured concentrations with numerical Air Quality Standards for ambient air.	Two types exist: 1. Odour concentration guidelines for specific compounds ($\mu g/m^3$); and 2. Ambient concentration guidelines set in Odour Units (ou_E/m^3)	There is no officially recognised ambient concentration standard set in Odour Units (ou_E/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 (ou_E/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 H_2S. 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 ❑ Combustion oxidation ❑ Catalytic oxidation ❑ 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# 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.

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[Φ], 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[14] 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.

[Φ] 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_2S) 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_2S). 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

Acceptability criterion	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.
Analytical assessment	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.
Anosmia	Lack of sensitivity to olfactory stimuli – unable to detect odours at all (compare with hyposmia).
Area source	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).
"Best practicable means" or BPM	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: "*practicable*" 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. 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.
CEN Olfactometry Standard	BS EN 13725: 2003, Air Quality – Determination of Odour Concentration by Dynamic Oflactometry.
Detection threshold	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.
Diffuse sources	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.
Exposure	Concentration x duration x frequency of the odour to which a receptor is exposed.

Dilution factor	The dilution factor is the ratio between flow or volume after dilution and the flow or volume of the odorous gas.
Fugitive releases	Unintentional emissions from e.g. flanges, valves, doors, windows – that is, points which are not designated or intended as release points.
Diffuse sources	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.
Dilution factor	The dilution factor is the ratio between flow or volume after dilution and the flow or volume of the odorous gas.
Emission factor	The emission per unit product (e.g. for wastewater treatment works expressed in this report the emission rate in $ou_E .s^{-1}$ per kg BOD, in screened sewage).
European odour unit, ou_E m^{-3}	That amount of odorant(s) that, when evaporated into 1 cubit 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.
European Reference Odour Mass (EROM)	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 µg n-butanol (CAS 71-36-3). Evaporated 1 cubit metre of neutral gas this produces a concentration of 0,040 µmol/mol.
Hedonic tone	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.
Hedonic scale	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.
Hyposmia	Partial inability to detect odours (compare with anosmia).
Odorant	A substance which stimulates a human olfactory system so that an odour is perceived.

Odorant flow rate

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 c_{od} and the outlet velocity v and the outlet area A or the product of the odour concentration c_{od} and the pertinent volume flow rate V, in e.g. m^3/h. Its unit is ou_E/h (or ou_E/min or ou_E/s, respectively).

Note: The odorant (emission) flow rate is the quantity equivalent to the emission mass or volume flow rate, for example in dispersion models.

Odour abatement (efficiency)

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.

Odour concentration

The amount of odour present in cubic metre of sample gas at standard conditions. The odour concentration is measured in European odour units ($ou_E\ m^{-3}$). The odour concentration at the detection threshold is defined to be 1 $ou_E\ m^{-3}$. 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.

Odour detection

To become aware of the sensation resulting from adequate stimulation of the olfactory system.

Odour sensitive receptor

The closest fixed building or installation where odour annoyance may occur, such as residential homes, school, hospital, overnight facility for holidays etc.

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.

Odour unit

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.

Offensiveness	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.
Olfactometer	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.
Olfactometry	Measurement of the response of assessors to olfactory stimuli. (ISO 5492).
Olfactory	Pertaining to the sense of smell (ISO 5492).
Olfactory receptor	Specific part of the olfactory system which responds to an odorant (after ISO 5492).
Olfactory stimulus	That which can excite an olfactory receptor (ISO 5492, modified).
Panel member	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.
Point source	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.
ppb	Parts per billion.
ppm	Parts per million.
Recognition threshold	The odour concentration which has the probability of 0.5 of being recognised 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.
Sample	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.
Sensitive receptor	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.
Sensory	Relating to the human response to a particular stimulus (in this case, odour). Compare with 'analytical' methods of assessment.
Sensory fatigue	Form of adaptation in which a decrease in sensitivity occurs (ISO 5492).

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

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