Horizontal Guidance Note

IPPC H1

Integrated Pollution Prevention and Control (IPPC)

Environmental Assessment and Appraisal of BAT

ENVIRONMENT AGENCY

ENVIRONMENT
AND HERITAGE
SERVICE

SEPA
Scottish Environment
Protection Agency

Commissioning Organisation
Environment Agency
Rio House
Waterside Drive
Aztec West
Almondsbury
Bristol BS32 4UD

Tel 01454 624400   Fax 01454 624409

First Published 2002

ISBN 0 11 3101082

Record of changes

Version	Date	Change
V1	Jun 2001	Limited internal consultation, pre-release to EAC.
V2	Jul 2001	Changes following June EAC meeting, mainly to spreadsheet structure. Internal consultation and working draft issued with the spreadsheet for use by Applicants in the Cement and Lime, Iron and Steel and Non Ferrous Metals sectors and to other individual Applicants at Account Manager's Discretion.
V3	May 2002	Working draft issued for use by Applicants in sectors entering PPC from May 2002 and other individual Applicants at the Regulator's discretion. Major changes to assessment methods for deposition to land, noise, odour, waste and accident risk; some minor revisions to methods for air and water. EQSs, EALs for air and water and POCP values have been updated. Major re-working of electronic tool into Access database format.
V3.1	July 2002	Consultation draft with minor revisions.
V4	March 2003	Incorporating consultation comments.
V5	June 2003	Modification of Modules 2 and 3 and Appendix F
V6	July 2003	Minor revisions re human health impacts

Note:

Written comments or suggested improvements should be sent to Mark Maleham by email at mark.maleham@environment-agency.gov.uk or at the address above.

Executive summary

This guidance has been produced by the Environment Agency for England and Wales in collaboration with the Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment and Heritage Service (EHS). Together these are referred to as "the Regulator" in this document. Its publication follows consultation with industry, government departments and non-governmental organisations.

What is IPPC?

Integrated Pollution Prevention and Control (IPPC) is a Regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. It involves determining the appropriate controls to protect the environment through a single Permitting process. To gain a Permit, Operators will have to show that:

- they have developed proposals to apply the 'Best Available Techniques' (BAT) (and certain other requirements), taking account of relevant local factors
- that no significant pollution is caused.

The aim of this Guidance

The purpose of this IPPC Horizontal Guidance Note for Environmental Assessment and Appraisal of BAT is to provide supplementary information, relevant to all sectors, to assist Applicants in responding to the requirements described in the IPPC Sector and General Guidance Notes. In particular, this note provides:

- methods for quantifying environmental impacts to all media
- a method for calculating costs of environmental protection techniques
- guidelines on resolving cross media conflicts and making cost / benefit judgements.

The methodology can be used either:

a) to conduct an **OPTIONS APPRAISAL** of candidate techniques to determine BAT to control selected releases from an installation because:

  - deviation from indicative BAT in Guidance Notes is proposed
  - several candidate Best Available Techniques exist
  - no indicative BAT is provided in Guidance Notes.

or

b) to carry out an **ENVIRONMENTAL ASSESSMENT** of the overall impact of the emissions resulting from the installation as a whole, in order to:

  - confirm that the emissions are acceptable (ie do not cause significant pollution)
  - identify priority emissions or environmental risks for further improvement.

The guidance consists of 6 basic modules:

module	aim of module
1	define the objective of the assessment and options to be considered
2	quantify the emissions from each option
3	quantify the environmental impacts resulting from the emissions
4	compare options and rank in order of best overall environmental performance
5	evaluate the costs to implement each option
6	identify the option that represents the Best Available Technique, by balancing environmental benefits against costs.

H1 Software tool

A software tool has been developed to accompany this guidance. This can be used to input most of the data requirements, perform calculations and present the environmental impact and cost information. The use of this software tool should greatly simplify the process and help to ensure that information is provided in a consistent and transparent format. However, note that the Operator will usually need to provide supplementary information in addition to that calculated in the software, that covers the interpretation and decision-making process as well as any further detailed assessment that has been undertaken outside of the steps included in this methodology.

Using the guidance

The following method of working is suggested:

- read the introduction to the H1 guidance and study Figure 1 to understand the process steps
- start entering data into the software tool reading the relevant modules in the Guidance at each stage. The software makes it clear which sections of guidance text are applicable.

CONTENTS

1 Introduction

1.1 About this document

Aim of this guidance

Integrated Pollution Prevention and Control (IPPC) is a Regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities (see Reference 1 and Reference 2). To gain a Permit, Operators will have to show that:

- their proposals represent the Best Available Techniques (BAT) to prevent and minimise pollution from the installation
- that no significant pollution is caused.

The essence of BAT is that the selection of techniques to protect the environment should achieve an appropriate balance between the environmental benefits they bring and the costs to implement them. The aim of this document is to provide a methodology by which the Operator can present the relevant cost and environmental information and justify that they have achieved the appropriate balance of costs and benefits to select the Best Available Techniques.

In addition, the Operator should demonstrate that no significant pollution is caused, by presenting an assessment of the environmental impact of emissions from the activities as a whole. The environmental impacts which should be considered are those that may be harmful to human health or quality of the environment, cause offence to human senses, result in damage to material property or impair or interfere with amenities or other legitimate use of the environment. This guidance provides a structured methodology to assist the Operator to make this assessment.

In summary, the methodology within this guidance can be used either:

- to conduct an **OPTIONS APPRAISAL** of candidate techniques to determine BAT to control selected emissions from an installation,

or

- to carry out an **ENVIRONMENTAL ASSESSMENT** of the overall impact of the emissions resulting from the installation as a whole.

The methodology consists of the following basic steps:

The H1 methodology

- Define the **objective** of the assessment and the **options for pollution control**
- Quantify the **emissions** from each option
- Quantify the **environmental impacts** of each option (bearing in mind that the impacts include harm to human health or quality of the environment, offence to human senses (for example odour) damage to material property, impairment or interference with amenities or other legitimate use of the environment)
- **Compare options** and rank in order of **lowest environmental impact**
- Evaluate the **costs** to implement each option

H1 software tool

This guidance document explains the methods for assessing impacts and costs, provides guidelines for determination of BAT and provides information on environmental benchmarks and their derivation. In addition to this document, there is an accompanying H1 software tool[1] that can be used to input data on emissions, perform calculations and present the environmental impact and cost information.

Much of the information requirements can be met by completion of the software modules, although this should be supplemented where necessary by additional information and qualitative judgement.

This particular methodology is not obligatory, but the advantages of using it are that it provides a structured procedure, which addresses the specific requirements of the PPC Regulations. In addition, it indicates the degree of detail and rigour with which the Regulators expect an environmental assessment to be carried out. By following the guidance, Operators will be able to provide an audit trail to support the selection of their proposed techniques, which will assist Regulators to determine a new application or review an existing Permit. Operators who wish to use alternative methodologies must ensure that an equivalent level of assessment is made, preferably by prior consultation with the Regulator.

---

[1] The database tool is currently under development and will be released at a later date.

Relationship of this Note to IPC BPEO Assessment Guidance

This methodology uses many of the principles and methods of E1 Guidance Note "Best Practicable Environmental Option (BPEO) Assessments for Integrated Pollution & Control" (see Reference 3). However, this new guidance note revises and updates some of the components of E1 and integrates the further considerations required under the IPPC regime, such as:

- the considerations to be taken into account to determine BAT under Regulation 3 and Schedule 2 of the Pollution Prevention and Control Regulations 2000 (see Reference 2).
- the greater emphasis on use of preventative measures

Where a BATNEEC/BPEO assessment has already been completed for an existing site under the IPC regime, it may be appropriate to either submit such existing documentation or rework the assessment according to this guidance. It must be stressed that any existing assessments must be relevant to the current situation at the site, reflecting any technological or economic changes, and that they meet the wider requirements of the PPC regulations.

Applicability of H1 guidance

This guidance applies to activities undertaken by most industrial sectors covered by the PPC Regulations. For certain PPC activities such as Intensive Livestock and Landfill, or those sectors for which Standard Rules have been derived, there may be alternative environmental assessment procedures that are more appropriate. Operators should also refer to the relevant IPPC Sector guidance notes for further information on the applicability of H1 to particular activities and seek advice from the Regulator if in doubt.

Operators should also be aware that there may be pollutant-specific reduction programmes that require measures to be taken in addition to any resulting from the assessment made using this methodology. Such programmes may be established for the most highly persistent, bioaccumulative and toxic substances for example.

1.2 When to use this methodology

This guidance forms part of an integrated package of guidance for PPC applicants. Operators should refer to the package as a whole when making their applications as this will describe the application procedure, accompanying guidance and the requirements of the PPC Regulations in more detail. This section provides an explanation of the situations when an Operator may need to conduct either an options appraisal of techniques to meet BAT or an assessment of environmental impact for the installation as a whole.

1.2.1 Options appraisal of BAT

BAT is defined in the PPC Regulations as "the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent, and where that is not practicable, generally to reduce emissions and the impact on the environment as a whole". This is further defined as below:

What is BAT ?

Definition of Best Available Techniques

"Best" – means the most effective techniques for achieving a high level of protection of the environment as a whole.

"Available" – means techniques developed on a scale which allows them to be used in the relevant industrial sector, under economically and technically viable conditions, taking into account of the costs and advantages.

"Techniques" – includes both the technology and the way the installation is designed, built, maintained, operated and decommissioned.

In addition to the above definitions, the PPC Regulations describe several considerations to be taken into account in the determination of BAT, as described under Regulation 3 and listed in Schedule 2. These are presented in Appendix A.

Assessing BAT at the installation level

In order to obtain a Permit to operate an installation covered by IPPC the Operator must demonstrate that that the best available techniques are being, or will be, used. The Sector Guidance explains how an Application for an IPPC Permit should be structured and the information which should be provided. It then lays down the indicative BAT standards and benchmark emission levels, which should normally be achieved in that sector. **In many cases, the requirements for IPPC may be demonstrated simply by implementing the indicative BAT as given in the relevant sector IPPC Technical Guidance Note. Provided that the environmental impact that results from the application of indicative BAT is acceptable, there should be no need for further appraisal of BAT at the installation level.** However, there are often circumstances where an Operator needs to provide an installation-specific assessment to justify that BAT is being implemented.

Indicative BAT provided in IPPC Technical Guidance Notes or BREFs is based on an analysis of the costs and benefits for typical or representative plants within that sector. When assessing the applicability of the sectoral, indicative BAT standards at the installation level, departures may be justified on the grounds of the **technical characteristics** of the installation concerned, its **geographical location** and the **local environmental conditions**. Further information on this can be found in the "Guide for Applicants" and "IPPC: A Practical Guide", (see References. 4 and 5). This is because the most appropriate technique may depend upon local factors, which can affect both the overall environmental impact of a technique as well as the costs of its implementation, which cannot always be determined at a sector level. Where the most appropriate technique at the local level is not self-evident, a local assessment of the costs and benefits of the available options may be needed to establish the best option.

Therefore, the approach to be taken in determining BAT for an installation will usually be a combination of compliance with indicative sector BAT, together with installation-specific BAT assessment for those aspects, which require local circumstances to be taken into account.

In summary:

When is an OPTIONS APPRAISAL of BAT required ?

BAT may be demonstrated by:

- compliance with the sector-level indicative BAT performance described in IPPC Sector Guidance Notes;

or

- by conducting an installation-specific **OPTIONS APPRAISAL** of candidate techniques (e.g. using this H1 methodology).

(In both cases you will also need to demonstrate that the environmental impact of the proposed BAT is acceptable – see 1.2.2 below)

An installation-specific OPTIONS APPRAISAL of BAT is usually carried out where:

- more than one candidate for BAT exists for the prevention or minimisation of a particular pollutant or pollutants;
- an Operator proposes to deviate from indicative BAT given in the Regulators' guidance;
- no indicative BAT is available for the activity, as may be the case for a new technology or process.

Where more than one candidate exists for BAT, this is usually indicated in Sector Guidance Notes, along with a description of the alternative techniques. Such situations commonly arise when there is a need to balance "trade-offs" between reducing one pollutant and generation of other environmental impacts such as waste or increased energy use, or where the quality of the local environment may have a major influence.

Where an Operator proposes to deviate from indicative BAT in the Sector Guidance Notes, this is usually because of installation-specific reasons. The basis for which departures can be justified is covered in the "Guide for Applicants" (see Reference 4) and can take into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions.

The basic rule in these cases is that you should compare a range of options on the basis of costs and benefits, and propose what you think is most appropriate to meet the requirements of the PPC Regulations. The level of detail required will depend on the environmental significance of the matter in question. A structured methodology such as the one presented in this document should be applied.

1.2.2 Environmental assessment

When is an environmental impact assessment required ?

One of the general principles of IPPC is that installations should be operated in such a way that no significant pollution is caused. To demonstrate this, the Operator should provide an assessment of potential environmental effects (which may range from impacts on human health to transboundary effects) of the foreseeable emissions from the entire installation. **In some circumstances, an Operator may be required to implement controls beyond the indicative BAT performance described in Sector Guidance Notes, in order to safeguard the local environment.**

The installation-wide environmental assessment should always be conducted once the Operator has identified proposed BAT for the installation as a whole, in order to confirm that the combination of the techniques will not lead to significant pollution. In addition, an environmental assessment of an existing installation may be carried out as an initial step to establish the environmental performance as the "base case", before considering potential improvements to individual activities or the installation as a whole. This can help to establish the key environmental priorities, particularly in the case of complex installations and integrated activities. In this case, the Operator is still required to demonstrate that the techniques employed represent BAT for the prevention or minimisation of pollution. In summary:

An **ENVIRONMENTAL ASSESSMENT** of the impact of the installation as a whole is usually carried out:

- ***for existing activities***, to establish the current performance and environmental priorities in order to guide the Operator in the selection of BAT;

and/or

- ***for new and existing activities***, to confirm that proposals for BAT for the installation as a whole are acceptable and do not cause significant pollution.

1.2.3 Integrating Environmental Assessment & Options Appraisal into Business Activities

The timing of assessment in relation to the PPC application

Typically, projects for new industrial activities, or changes to existing activities, go through a number of business development stages before implementation. At the initial stages of project definition a large number of process routes available for the manufacture of a product may be available, from which a limited number are selected for further evaluation. Once the project has been defined, detailed designs may be prepared for only one or two options before the final process is chosen and implemented.

The greatest opportunity for pollution prevention arises during the early stages of project definition. As the project progresses through to the development stages of selection, design and build, there is a reduction in the options available to reduce pollution. Early consideration of environmental requirements of a project in the business development stages of the project is also desirable to ensure that key environmental issues are not overlooked leading to problems of compliance with Regulatory requirements at later stages of the project. It is essential, therefore, that the Applicant has addressed all relevant environmental issues as early as possible.

Operators should refer to the detailed guidance on environmental standards and indicative Best Available Techniques, which are provided in the Regulators' IPPC Technical Guidance Notes for different industrial sectors at an early stage of project development. In addition, the Operator should also consider specific local factors of relevance to the installation.

Pre - Application Discussions

Operators are encouraged to discuss options for new activities and changes to existing activities with Regulators during the early stages of project development before significant resources are put to detailed design. This ensures that all relevant considerations are taken into account in the most resource-efficient manner with no "surprises" to Regulator or Operator. However, pre-application discussions must not imply any advance agreement as to the outcome of any application, (see Reference 5 - A Practical Guide to IPPC).

If an IPPC installation requires planning permission, it is recommended that the Operator make both applications in parallel whenever possible. Although the scope of requirements for an environmental impact assessment for planning purposes are different from those of IPPC, several of the information requirements are the same.

Benefits of Environmental Assessment & options appraisal

The use of a structured assessment procedure to assess environmental impacts and costs and benefits of control techniques can lead to substantial savings in costs, particularly when reviewing activities within existing installations. Experience of using the previous E1 IPC Guidance for BPEO assessment demonstrated that through the systematic appraisal of costs and environmental benefits, opportunities for reduction in waste disposal or energy, water and raw materials consumption and other process efficiencies can be identified.

In addition, the information on environmental assessment presented as part of the Regulatory requirements can be used for company environmental reporting purposes.

1.3 How to use this methodology

1.3.1 The structure and modules

A pictoral overview of the methodology is provided in Figure 1. The methodology provides a structured procedure for the assessment of environmental impact of pollution from IPPC activities, the evaluation of the costs of techniques to control these emissions and balancing of these costs with environmental benefits to identify the Best Available Techniques.

The methodology is presented in a series of separate modules, shown below and in Figure 1. The modules include individual steps to ensure that all the relevant information, assessment and decision-making is presented in a clear and consistent manner that includes all the requirements for the selection of BAT, according to the PPC regulations. This format is designed to improve the consistency with which information is provided and presented as part of environmental assessments, thus assisting in the transparency of the Operator's decision-making process and the ease of determination of the application by Regulators.

module	aim of module
1	define the objective of the assessment and options considered
2	quantify the emissions from each option
3	quantify the environmental impacts resulting from the emissions
4	compare options to rank in order of best overall environmental performance
5	evaluate the costs to implement each option
6	identify the option that represents the Best Available Technique, by balancing environmental benefits against costs.

The modules are designed to incorporate the input of information on the activity, calculation steps, tools for prioritisation, evaluation and modelling and the use of technical and cost data. Each step contains specific instructions followed by supporting information on how to carry out that part of the assessment procedure.

1.3.2 Simplifying and adapting the methodology

Depending on the type and scope of the assessment being carried out, the Operator may need to use only some of the modules. Figure 1 and the table below illustrate the applicability of modules.

Type of assessment:	Modules to complete:
OPTIONS APPRAISAL of candidate techniques for BAT	Do modules 1, 2, 3 and 4. Continue with 5 and 6 if necessary.
ENVIRONMENTAL ASSESSMENT for the activities as a whole	Do modules 1, 2 and 3 only.

The scope of activities within an installation that needs to be included in an OPTIONS APPRAISAL of BAT will depend on the objective of the assessment. In some cases, only part or parts of the installation will require inclusion in the assessment. In others, the entire installation may need to be included because the techniques to control a particular pollutant are integrated throughout all constituent components. The aim is for the Operator to use the methodology in the most practical fashion by defining the appropriate boundary of the assessment and avoiding unnecessary appraisal.

The modular format of the guidance allows the Operator to use shortened approaches for simpler activities, such as those with only a few control options or having releases only to one medium. The methodology also includes quantitative and qualitative techniques to screen emissions or impacts that are so small that they can be considered insignificant. This enables resources to be targeted in proportion to the environmental risk and complexity of the activities.

The Operator may also use the methodology in an iterative fashion for project scoping, to check the predicted environmental performance of candidate options or configurations before the full costing and selection process. Options can then be revised as required.

Note that the methodology should not be applied in an overly mechanistic fashion. The guidance and software tool set out a general structure for making environmental and cost assessments, but there may be circumstances where particular assessment methods within this structure could be adapted to suit the situation more appropriately. Particular areas where this is relevant are highlighted throughout the methodology.

1.3.3 The H1 software tool

H1 software tool

A software tool accompanies this guidance[2]. This should be used as a tool to assist in the calculation and presentation of information for the environmental assessment or BAT appraisal. In many cases, its use should greatly simplify the process as it can be submitted in support of either an appraisal of options or an assessment of overall impact. However, supplementary information may be needed in cases where very detailed assessment is required or where the installation is particularly complex. In addition, further qualitative interpretation will usually be required in order to justify BAT or environmental assessment decisions based on the information generated by the software tool.

The following is suggested as the most efficient manner of working:

- read this introduction and study Figure 1 to understand the process steps

---

[2] The software tool is currently under development and will be released at a later date.

- start entering data into the software, reading the relevant modules in the following sections of this guidance at each stage. The software makes it clear which sections of guidance text are applicable.

Guidance on how to use the software is contained within the package itself and in the user instructions in Appendix J of this document.

1.3.4 Presenting the Information

The Operator should provide all the necessary information to demonstrate that the objective of the assessment has been fulfilled. This will usually consist of emissions data and information on the local environment, results of the assessment of environmental impacts and costs, together with a description of the interpretation, assumptions and qualitative judgements made in reaching decisions regarding selection of BAT or environmental assessment.

The input data, comments and output pages (e.g. histograms) of the software tool can be used to provide much of the information. These should be submitted to the Regulator, together with any supplementary information used in the assessment process (e.g. dispersion modelling reports etc). In addition to this, the Operator will usually need to provide the qualitative information detailing the decision-making process as a separate report.

1.3.5 Sensitivity

When conducting options appraisals, the Operator should consider a sensitivity analysis of any key uncertainties or likely changes that might affect the choice of BAT. This should consider any key parameters that are likely to change over the foreseeable future operations of the activities, as well as assumptions of predicted performance or emissions from potential techniques. Examples of such situations that may lead to a change in the nature and pattern or emissions and their subsequent impacts, or a change in the balance of costs against the environmental benefits include:

- change of product or product specification
- change in output
- availability, quality or cost of raw materials or other key consumables
- availability and proximity of waste disposal, treatment or recovery options

The Operator may address these sensitivities by conducting additional appraisals, modifying the relevant parameters, and where this may affect the choice of BAT, providing a justification based on the likelihood of change.

1.4 Principles of the methodology

H1 follows the general principles of risk assessment methodologies as described in the joint Environment Agency, DETR and IEH document “Guidelines for Environmental Risk Assessment and Management” (ref 6).

The methodology consists of two basic components: the assessment of environmental impacts and the balancing of environmental impacts against costs. The methods derived for conducting these procedures are based on the following principles:

- the assessment of the direct impacts of emissions is based generally on prevention of harm to human and ecological receptors, using a set of defined environmental benchmarks which represent the maximum acceptable level of that substance to a receptor in the receiving medium;
- the assessment of the non-local or indirect impacts of emissions, where no maximum thresholds for the prevention of harm are available, is based on quantification of overall environmental burdens or risks;
- the scope of this methodology is based on the requirements of the IPPC Directive and whilst certain indirect emissions are included, it does not incorporate full Life Cycle Analysis (LCA) of the prescribed activities or activities that are not covered under IPPC (such as transportation);
- environmental impacts are compared directly with the costs of controlling them, rather than by assigning monetary values to the impacts;
- the costs of controlling polluting emissions are based on the private costs of implementation of techniques to the Operator and do not include wider social costs.

Further detail on some of these principles is provided within the relevant stage of the methodology.

The derivation of methods and criteria used within this guidance are described in reports of work by expert consultants commissioned by the Environment Agency. These are referenced throughout the document.

FIGURE 1 - THE ASSESSMENT PROCESS

MODULE 1

Define the **SCOPE** of the activities, and for options appraisals identify the **OPTIONS**

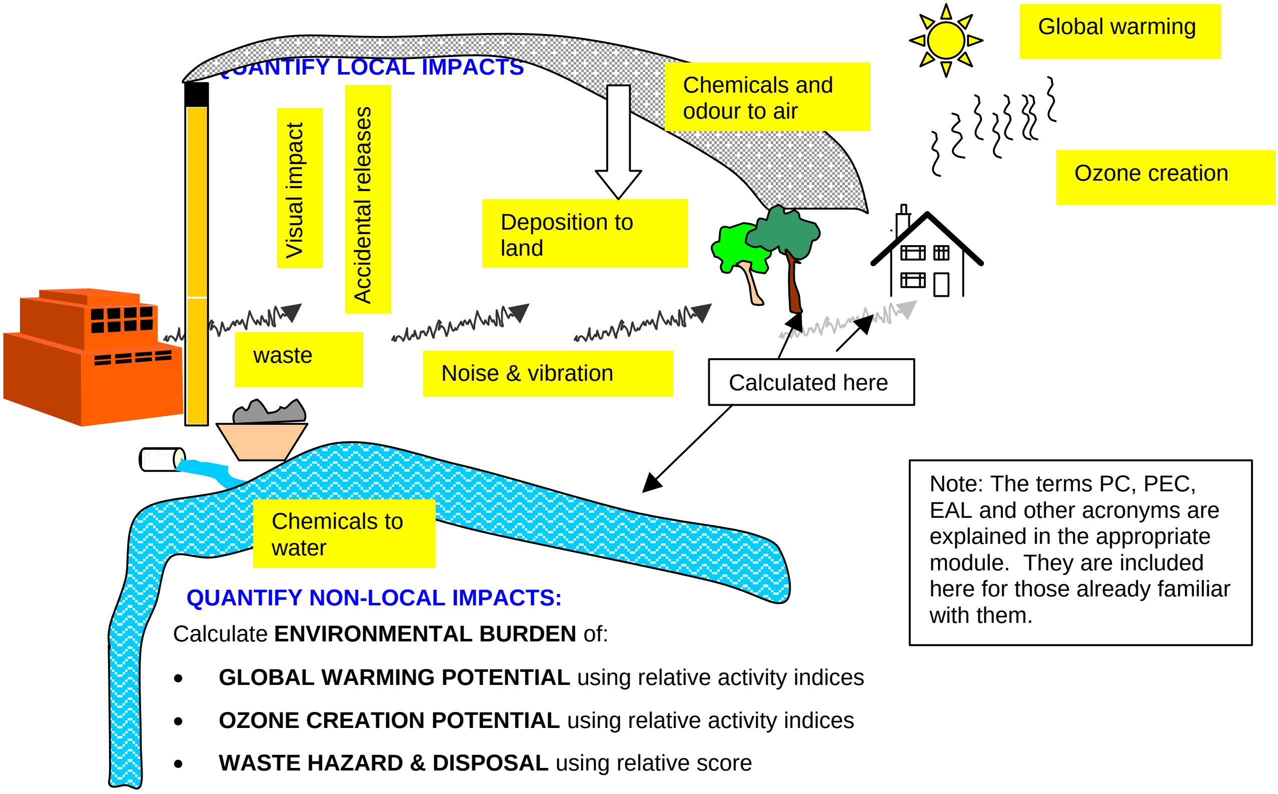
MODULE 2

List the **EMISSIONS** and release points

MODULE 3

QUANTIFY LOCAL IMPACTS

- **ESTIMATE** the levels in the environment after dispersion using simple formulae, (e.g. calculate PC)
- **SCREEN** out emissions that are unlikely to have significant impact (e.g. PC<1%EAL)
- Use the guidelines to see if detailed **MODELLING** is required. Refine process contributions if needed.
- **COMPARE** levels against EQSs or EALs and other benchmarks and **REJECT** situation for any releases which are unacceptable
- **SUMMARISE IMPACTS,** using **NORMALISATION** against **BENCHMARKS** where appropriate, e.g. $EQ_{(air)}$, $EQ_{(water)}$, $EQ_{(land)}$



QUANTIFY NON-LOCAL IMPACTS:

Calculate **ENVIRONMENTAL BURDEN** of:

- **GLOBAL WARMING POTENTIAL** using relative activity indices
- **OZONE CREATION POTENTIAL** using relative activity indices
- **WASTE HAZARD & DISPOSAL** using relative score

SUMMARISE non-local impacts, using **TOTAL BURDEN** where appropriate

Note: The terms PC, PEC, EAL and other acronyms are explained in the appropriate module. They are included here for those already familiar with them.

MODULE 4

COMPARE OPTIONS to identify the option with lowest environmental impact

1. If best option is evident and will be done. STOP HERE

2. If there are **CROSS MEDIA ASPECTS** to resolve: Use guidelines & judgement to resolve them. If Best option is <u>now</u> evident and will be done. STOP HERE

3. If you wish to justify other than best option on grounds of cost GO TO MODULE 5

MODULE 5

CALCULATE COSTS of each option

capital and operating costs presented as **ANNUALISED COSTS**

Use standard **PROFORMA**

Specify discount rate and asset life

MODULE 6

SELECT BAT

Use guidelines & judgement to conclude BAT

USE COST BENEFIT CRITERIA to assess if it should be done e.g:

- £/t pollutant abated
- impact on product price

Assessment of environmental impact

BAT appraisal

2 ASSESSMENT METHODOLOGY

MODULE 1: Describe the Scope & Options

Aim

The aim of this module is to:

- state the reason for conducting the assessment
- in the case of **ENVIRONMENTAL ASSESSMENT** of the whole installation, describe the scope of the activities to be included in the assessment
- in the case of **OPTIONS APPRAISALS,** identify candidate options for BAT by considering all relevant techniques to prevent and minimise pollution from the activities, and their scope

Depending on the reason for the assessment, you will need to complete different modules of the guidance. The table below summarises which parts of the methodology are applicable in each case.

Type of assessment:	**Modules to complete:**
ENVIRONMENTAL ASSESSMENT for the activities as a whole	Do modules 1, 2 and 3 only.
OPTIONS APPRAISAL of candidate techniques for BAT	Do modules 1, 2, 3 and 4. Continue with 5 and 6 if necessary.

1.1 Describe the Objective of the Assessment

1. **Briefly summarise the objectives and reason for the assessment in terms of the main environmental impacts or emissions to be controlled.** This can be entered into the software tool as indicated.

   Examples:

   - “To appraise several candidate options for the prevention and minimisation of releases to air of NOx and SO_2 for a new waste incineration plant, in order to select BAT”.
   - “To appraise the costs and benefits of applying indicative BAT to further control BOD discharged to water at an existing paper mill”.
   - “To assess the existing environmental impact of all emissions from all activities within an installation for the production of cement, prior to investigating further controls”.
   - “To assess the environmental impact of all emissions from all activities within an ammonia production plant to demonstrate that the proposed BAT should not cause significant pollution”.

1.2 If conducting an ENVIRONMENTAL ASSESSMENT: List the activities included in the assessment

1. **Define the scope of the assessment,** by briefly describing which of the activities covered in the Permit are included **(note1)**.

   This information can be entered into the software tool.

Notes

1. When conducting an **ENVIRONMENTAL ASSESSMENT** of the impact of the installation as a whole, the scope should cover only those activities included within the Permit (or Permits). Any other operations that may be conducted at the "site" but are not in the Permit, or upstream or downstream operations carried out at other locations, are usually excluded. However, in certain circumstances, it may be relevant to include specific impacts that relate to these activities but that actually occur outside of the physical scope of the installation (for example the indirect impacts associated with energy used in the installation but generated elsewhere). Circumstances where the impacts of indirect emissions are relevant are described at the relevant module of the methodology. **If in doubt regarding the scope of the assessment, consult the local Regulator.**

1.3 For OPTIONS APPRAISAL: Identify the Candidate Techniques

1. **If you are using H1 to do OPTIONS APPRAISALS of candidate BAT, identify all reasonably applicable options of techniques** (note 1), including:
   - a brief description of individual techniques or configurations of techniques selected for each option, and the activities with which they are associated (for existing activities, the current situation may represent the "base case" option). Example formats are provided below.
   - justification why any techniques generally applicable to the industrial activity have not been selected for assessment.(note2) (This should usually be based on reasons of technical incompatibility or clearly excessive costs such as those involving major replacement or re-build).
   - for new projects, whether any initial environmental assessment that was done at the project evaluation stage, or any screening of technology or process routes prior to this assessment, particularly where this has a bearing on environmental performance.(note 3)

   This information can be entered into the software tool.

   Note **Once a series of options have been generated for the proposed project, it is recommended that the Operator discuss these with the local Regulator to check both parties agree that the options are suitable. This may save the Operator from spending resources on assessment of options, which are unlikely to meet the required environmental performance.**

Notes

1. For **OPTIONS APPRAISAL** of candidate BAT, list the main activity or activities to which the emissions control options are applicable and any other activities that will be affected by the candidate control options on the main activities. For example, if changing the raw material is one of the candidate options for controlling emissions for the selected activity, and this also affects emissions from other downstream activities, then all the affected activities should be included in the scope. Only activities that are covered under the scope of the Permit should be included.

   Often the relevant techniques or combinations of techniques to control pollution are well known and easy to define. In most cases appropriate techniques will be described in BREFs and Section 2 of the relevant IPPC Sector Guidance Note. Reference should be made to these. The Operator should also consider any new or innovative techniques of relevance to the activity which have emerged since publication of the relevant IPPC Guidance Notes.

   Techniques can include design, process integrated techniques, selection of raw materials and operational methods as well as abatement and treatment techniques. Priority should be given to the selection of techniques which completely prevent emissions (e.g. prevent releases to water or stop the use of a hazardous raw material) or clean technologies where

available (e.g. by specification of process design and equipment selection), as these will tend to result in the lowest environmental impact.

Options may consist of single techniques or combinations of techniques depending on the scope of the proposed activity. For example, different techniques to control the same pollutant may take place in different parts of an industrial process, e.g. selection of raw materials, design of process equipment, method of operation or effluent treatment. For ease of use, techniques can be grouped under the headings in Section 2 of the IPPC Sector guidance notes, if appropriate. The Operator should also consider combinations and synergies between different configurations of techniques, especially when considering control of several pollution sources.

The expected performance level of techniques should be provided. Note that techniques should be assessed according to their optimum potential and care should be taken to avoid arbitrary performance or control levels, such as assuming the same emission limit value for different options.

In cases where more than one BAT issue is being appraised, it may be appropriate to generate configurations of measures which address all issues together. This is most appropriate in the assessment of integrated techniques which affect more than one pollutant, as it allows trade-offs between reduction of one pollutant at the expense of another to be fully appraised.

However, care must be taken that this does not increase the complexity of the assessment to the extent that it is difficult to judge the individual cost and benefit components of each individual technique. For example, it is usually not appropriate to combine NOx control with particulate control, as distinct control techniques are generally used for each pollutant. However, acid gas scrubbing and particulate removal may use the same control techniques and it would then be appropriate to combine them in the assessment.

Typically, two or three options are generated for appraisal in simpler activities. A wider range of techniques, particularly preventative techniques, is generally feasible for new installations than existing installations. See the examples provided below.

2. The Operator should consider all the alternative techniques described in the Guidance Notes and justify why any techniques or options identified therein have not been considered for appraisal. Techniques may be eliminated for installation-specific reasons such as technical incompatibility to the existing process, physical constraints of the site, age of existing equipment etc. Where there may be an economic case for eliminating particular techniques, this should usually be backed up with a costs and benefits appraisal unless the costs are clearly excessive. Contact the local Regulator if it is unclear whether costs can be considered to be clearly excessive.

3. Prior screening of project options may be appropriate in certain cases involving complex product development or technology routes, such as chemical synthesis. Where relevant, reference should be made to Sector Guidance Notes, which provide some information on environmental considerations for different technology routes. An Operator may be required to justify the grounds on which a particular technology route has not been included in an options appraisal for BAT, when there are clear environmental advantages to that technology. However, most sectors have well-defined process routes for which prior screening of projects is not necessary.

Simple Example:

Options to Control Releases to Water from an existing Chemical Pigment Process

Activity	Option 1 (base case)	Option 2	Option 3
effluent treatment	existing ETP: settlement tanks plus pH adjustment	use of alternative reagent: mercury-free sodium hydroxide solution in existing ETP	improved ETP with use of mercury-free sodium hydroxide solution

ETP = Effluent Treatment Plant

In this case, the scope of the assessment is only one activity within the installation.

Complex Example:

Summary of Options to Control Emissions to Air of Acid Gases and NOx from a New Waste Incinerator

Activity	option 1	option 2	option 3	option 4	option 5	option 6
selection of raw materials	calcium sorbent urea reagent	sodium sorbent urea reagent	sodium sorbent urea reagent	sodium sorbent ammonia reagent	calcium sorbent urea reagent	sodium sorbent ammonia reagent
waste handling	mix and segregate	mix and segregate	mix and segregate	mix and segregate	none	none
furnace design & control	moving grate fgr + air control	fbc fgr + air control	moving grate fgr + air control	moving grate fgr + air control	moving grate fgr + air control	moving grate fgr + air control
flue gas treatment	SNCR-urea semi dry scrubber	SNCR-urea Dry scrubber	SNCR-urea Dry scrubber	SNCR-NH3 semi-dry scrubber	SNCR-urea Wet scrubber	SCR semi-dry scrubber

techniques for acid gases
techniques for NOx

FGR = flue gas recirculation
SNCR = selective non-catalytic reduction
SCR = selective catalytic reduction
FBC = fluidised bed combustor

In this example, control techniques are applicable at several stages of the process, so a process-integrated assessment may be more appropriate. However, care must be taken at a later stage to present the costs and benefits of the techniques to control acid gases separately from those for NOx removal.

MODULE 2: Emissions Inventory

Aim

The aim of this module is to produce an inventory of sources and releases of polluting substances from each option. This is used as the basis for the subsequent evaluation of environmental impacts.

2.1 Provide an Inventory of Emissions

1. **Provide an inventory of all sources and emissions of pollution associated with the activities included in the assessment**, describing the nature, quantities and media into which they are released. The information may be entered directly into the H1 software tool.

   For options appraisal of BAT, a separate inventory should be provided for each option.

   If the activities lead to variation in emissions over time, eg due to changes in output or product type, the operator should consider whether separate assessments covering the range of expected conditions should be made(note 1).

   The following emissions sources should be included:

   - point source emissions to surface water, groundwater and sewer (note 2)
   - point source emissions to air
   - fugitive emissions to all media
   - abnormal (foreseeable but unplanned) emissions from emergency relief vents, flares etc(note 1).
   - emissions of waste, and consumption of raw materials, water and energy(note 3)
   - sources, type and level of noise(note 4)
   - sources and emissions of compounds that have potential odour risk(note 5)

   The following data relating to the emissions should be provided:

   - substances released(note 6)
   - for releases to water, the pH and temperature of the liquid effluent
   - source, including height, location, gas efflux velocity, total gas or water flow (note 7)
   - for releases to air, any other relevant information such as building effects
   - media to which it is released
   - predicted normal and maximum emissions(note 8), expressed, where appropriate as:
     - mass/unit time (e.g. g/s)
     - concentration (e.g. µg/m^3) and total flow (e.g. m^3/h)
     - annual mass emissions (e.g. tonnes/year)
   - statistical basis (note 8,9) (average, percentile etc) and the type of effects associated with the releases, ie long term or short term
   - if intermittent, the predicted frequencies
   - plant loads at which the data is applicable
   - specific consumption data for energy, water and waste (note 10)

2. Check that all options meet any statutory emissions limit values as laid down by EU Directives. These statutory limits are described in the relevant Sector Guidance Notes.

   Any options that fail to meet statutory emission limit values will not be Permitted and therefore should not be taken any further in the assessment.

Notes

1. Some industrial processes have marked changes in emissions over time. For example, power generators may change output in reaction to seasonal demand or changes between fuel costs. Similarly, complex chemical installations may produce different products or use different process routes at different times. In the power generation example, the Operator may decide to conduct a worst case assessment at maximum generating capacity as well as at the expected average load, in order to demonstrate satisfactory environmental protection at all output levels up to the maximum. A similar principle would apply in the case of the chemicals example; the Operator could identify a representative worst case situation (ie a particular product, process route or

combinations). Care should be taken that the scenario is realistic and only includes emissions that can occur at the same time.

In these cases it is difficult to provide definitive guidance that will suit quite different situations and the Operator is likely to be best placed to decide the approach that most suits the particular operations at their installation. If in doubt, it is recommended that the Operator discuss the scope with the Regulator.

2. Note that where water is abstracted from non-mains supply, it is any additional *increase* in emission concentration for a given substance over the background level, which should be used to calculate the environmental impact in this methodology.

3. ***Energy****.* There are a number of emissions associated with energy use. Direct emissions resulting from energy use within the activities (such as NOx, SO_2 etc) should be included according to the relevant source and medium to which they are released (e.g. under “releases to air”), except for carbon dioxide which should be listed separately according to the energy consumption proforma provided in the H1 software tool and shown below. In addition to any direct releases, the indirect emissions of carbon dioxide associated with imported energy (heat and/or power) should be provided [3]. Standard conversion efficiency and emission factors for energy are given in Appendix B (and are included in the H1 software tool) and further reporting protocols for energy are provided in H2 IPPC Technical Guidance for Energy Efficiency, (see Reference 7).

Energy sources, conversion efficiency and emission factors

Energy source	Location of emission	*Delivered to primary conversion factor	CO_2 factor (t/MWh, primary)
electricity from public supply	indirect	2.6	0.166
electricity from other source	indirect	Operator to specfiy	Operator to specify
renewable electricity	indirect	n/a	0
other imported energy (steam etc)	indirect	Operator to specify	Operator to specify
coal	direct	1	0.300
coke	direct	1	0.430
gas oil	direct	1	0.250
heavy fuel oil	direct	1	0.260
petrol	direct	1	0.240
liquid petroleum gas	direct	1	0.230
jet kerosene	direct	1	0.240
ethane	direct	1	0.240
naphtha	direct	1	0.200
refinery gas	direct	1	0.200
petroleum coke	direct	1	0.340
natural gas	direct	1	0.190
other (Operator to specify)	direct	1	Operator to specify

* This factor is for the conversion from delivered energy to primary energy, not taking into account transport or transmission losses. It is required for non-renewable sources of heat and power that are not generated directly at the installation, in order to estimate the actual CO_2 emissions at source.

Waste These releases relate to any wastes removed from the installation, or disposed of at the installation e.g. landfill. Wastes should be classified into the following categories, expressed as tonnes per annum: inert; non-hazardous; and hazardous.

Consumption of ***raw materials*** should be expressed on an annual basis in the appropriate units.

Water Consumption of water should be expressed as cubic metres per annum.

---

[3] The Regulators are also considering inclusion of other indirect pollutants emitted from primary energy generation. For example, where energy is used to control other environmental impacts, it may be necessary to assess the net benefits.

4. ***Noise*** The possible sources and type of noise should be listed. The source should be identified as either fixed or mobile, for the purposes of defining the distance to the nearest sensitive receptor. Noise type should be categorised as continuous or intermittent. For existing activities, any measured noise levels should also be listed. Information can be input into the format provided in the H1 software tool. See IPPC H3 Horizontal Guidance for Noise (Reference 8) for further information or SEPA Guidance on the Control of Noise at PPC Installations (www.sepa.org.uk/guidance/ippc/ppc_noise_guidance.pdf). Further characterisation is not needed at this stage and will depend on further risk assessment carried out in module 3.

5. ***Odour*** Sources and emissions of compounds with the potential for odour nuisance should be listed. This should include both point sources and fugitive sources. See IPPC H4 Horizontal Guidance for Odour (Reference 9) for further information. Information can be input into the format provided in the H1 software tool. Further characterisation is not needed at this stage and will depend on further risk assessment carried out in module 3.

6. Information on typical emissions for different industrial sectors can be found in Section 1.6 of the relevant IPPC Technical Guidance Notes, broken down by activity. In addition, a list of the main polluting substances is given in Schedule 5 of the PPC Regulations and reproduced here in Appendix C. The H1 software tool includes a list of the most common substances emitted from industrial processes. However, this list is not exhaustive and the Operator should enter all substances whether on the existing list or not.

   Grouping air pollutants The general approach for dealing with groups of similar compounds where full characterisation and composition is not known, is to assign a surrogate substance to represent 100% of the mass. The surrogate material should represent a worst case, ie the most harmful substance.

   - **VOCs**: Volatile organic compounds (VOCs) are commonly measured as a group. However, the composition of individual substances within these groupings may differ considerably between industrial activities. Where characterisation of VOCs has not been undertaken, the Operator could adopt a precautionary approach and assume that the composition is 100% benzene unless justification for an alternative assumption can be provided.

   - **Nitrogen Oxides**: Nitrogen oxide (NO) and nitrogen dioxide (NO_2) are commonly measured as “NOx”. However, benchmarks for human health are expressed as the individual constituents. In time, emissions of NO will oxidise to NO2 and so the following guidelines are recommended unless justification for an alternative assumption can be provided:

     - short term emissions: convert all measured or estimated nitrogen oxide emissions to NO_2 and assume 50% of this value as the short term NO_2 emission.

     - long term emissions: convert all measured or estimated nitrogen oxide emissions to NO_2 and use this value as the long term emission.

     In some cases it may be necessary to further characterise the composition, depending on the potential environmental risk, in order to determine the effects of individual components in more detail. Further guidelines on when this approach may be required are described later in module 3 of this methodology.

   - Particulate Material**: This can cause adverse health effects in its own right and therefore has an associated EAL. In addition, it may be relevant to consider the effects of constituent substances eg heavy metals, which will also have specific toxicity effects on different receptors. The Operator should specify the nature of the particulate material released and assess against substance specific benchmarks where relevant. As in the case of other groups of pollutants, where the composition is unknown, a worst case assumption should be made.**

   Complex Effluents Where sufficient chemical characterisation of aqueous effluent is not known in order to demonstrate satisfactory protection of the environment, the Operator may decide that a “whole sample” assessment such as Direct Toxicity Assessment (DTA) is more appropriate than a chemical specific method. In these cases, the Operator should identify that a DTA method is to be undertaken and present this information separately. Further information on DTA is provided in Appendix F and in the methodology for quantifying impacts of releases to water in section 3.5. In addition, further guidelines may be provided in Sector Guidance Notes of particular industrial activities where DTA is more appropriate.

7. **For emissions to air,** the effective height of releases can, in many cases, be assumed as the point of discharge to the atmosphere, i.e. top of the stack or vent, as any plume rise or momentum effects can be ignored at this stage. (They will need to be considered later if the screening process shows that more detailed assessment and modelling are required). However,

if either of the following circumstances apply, then the effective height of releases should be assumed as described below:

- **The effective height of release could be considered as zero** where the point of discharge:
    - is **less than 3m** above the ground or building on which it is located, or;
    - is **greater than 3m** above the ground or building on which it is located **but less than the height of any building within a distance 5L from the point of discharge** (where L is the lesser of the building height and the maximum projected width between two points the same height in the building). This criterion is based on the assumption that such releases may become entrained in the building wake cavity.

  The above criteria generally apply to releases considered to be fugitive.

- Where the height of the release is **greater than 3m** above the ground or building on which it is located but less than 2.5 times the height of the tallest adjacent building, the effective height of release can be estimated from:

$$U_{eff} = 1.66H\left(\frac{Uact}{H} - 1\right)$$

  Where:
  H is the height (m) of the tallest adjacent building within the distance 5L (where L is the lesser of the building height and the maximum projected width between two points at the same height in the building);

  U_{eff} is the effective stack height; and

  U_{act} is the actual (physical) stack height

6. For an existing installation or activity, the inventory should be based on measured data. This will be the “base case” situation when conducting appraisal of options to control pollution for an existing installation. For a new installation, and options considered besides the base case, estimates of releases are required. Where possible, estimates of releases should be backed up by information from pilot trials or similar operations elsewhere. Where uncertainties exist in estimated values, it is usual to assume the “worst case” and to state any assumptions made.

   Emissions from the proposed pollution prevention and control techniques should be evaluated in terms of the full performance capacity of that technique during normal operation.

   The Operator should describe the pattern of the releases in terms of variation in concentration over time in order to ensure that representative operational situations have been assessed. The Operator should describe the plant load at which the emissions are applicable, e.g. batch or continuous, average load or peak load. It may be necessary to evaluate more than one operating scenario in order to ensure that the impacts resulting from the worst case situation have been assessed.

   The emissions released from these different operational situations should be related to those that result in long term effects (e.g. continuous releases over a long time period, or regular batch releases, that do not result in great variation in concentration) and those that result in short-term effects caused by intermittent or periodic peak emissions at relatively high concentrations released over a short period of time.

7. It is important that releases are expressed according to any relevant standard conditions and that the statistical basis from which they are derived is provided. The reference conditions of substances in releases to air from point sources are: temperature 273 K (0 °C), pressure 101.3 kPa (1 atmosphere), no correction for water vapour or oxygen. **Further information on the measurement basis of certain substances is provided in Section 3.2 of the IPPC General and Sector Technical Guidance Notes.**

   The same averaging period should be used for comparison of emissions against environmental benchmarks. For example, most long term benchmarks are expressed as an annual mean and many short term benchmarks as an hourly mean. Note that there are certain exceptions to this which are important when considering compliance with statutory EQS. Some conversion factors are provided below:

Conversion factors for Different Averaging Periods (see Reference 14)

From To ⇨ ⇩	15 minutes	1 hour	8 hours	24 hours
1 hour	1.34	1	0.7	0.59

For example; to convert hourly data to 8 hourly data multiply by 0.7

8. Specific consumption data should be provided for performance indicator purposes as described in the relevant Sector Guidance Notes. The Operator should specify the most appropriate material or product on which to base the specific consumption data. These will also be described in Sector Guidance Notes, where relevant. The required data inputs are described in the software tool.

MODULE 3: Quantify Impacts

Aim

The aim of this section is to quantify the effects of emissions on the environment. This includes the following considerations (note 1):

- local and transboundary effects of emissions to air
- local effects of emissions to water
- local and long range effects from deposition to land of airborne emissions
- the risk of impacts from the consequences of accidents
- the effects of noise on local receptors
- visual impacts associated with operation of the process
- the effects of odour emissions on local receptors
- the potential of emissions to cause global warming by indirect effects
- the potential of emissions to cause photochemical ozone creation by indirect effects
- the indirect effects of waste hazard and disposal.

These emissions may have direct or indirect effects on human health, quality of the environment, offence to human senses, damage to material property or amenity value. The subsequent sections describe how the potential effects are assessed, whether in relation to specific receptors or general effect.

The general assessment method includes a number of steps:

- identify which of the above environmental impacts is relevant to the assessment by considering the possible pathways and receptors of emission sources from the activities.
- estimate the concentration of emitted substances after dispersion into receiving environmental media; (note 2)
- screen out insignificant emissions that do not warrant further investigation (note 3)
- carry out detailed modelling of the fate of emissions, where appropriate (note 4)
- check whether levels are acceptable in the local environment (note 5)
- summarise the impacts, using normalisation methods where appropriate.

This module provides methods for assessment of each of the above environmental considerations. Note that the method for assessing some of the environmental considerations consists of a simpler procedure than described above, using fewer steps.

Note that if any of the impacts are not relevant to the assessment they do not need to be addressed by the Operator, other than to provide a brief justification why they are not considered relevant.

Notes

1. The environmental considerations listed here are based on the requirements of the IPPC Directive, but are not exclusive. Other factors might be pertinent to any particular process at a specific location; for example, the following consideration may be applicable in certain circumstances:

    - Ozone depletion

    Chemicals containing chlorine and bromine such as CFCs and HCFCs, carbon tetrachloride, 1,1,1-trichloroethane, halons and methyl bromide, cause depletion of stratospheric ozone. EU and international agreements will lead to the phasing out of these substances, with some exemptions for essential or critical uses. Although there are a range of substances known to cause ozone depletion that are used or produced as by-products in industrial processes, industrial sources in total form only a small proportion of national releases. Despite this, there may be certain industrial processes for which the release of ozone depleting substances is significant. Operators of processes which have the potential to lead to releases greater than 100kg/year, expressed as CFC-11 equivalent on the basis of ozone depletion potential, should consult the Agency on the methods of quantifying these effects. Reference can be made to guidelines and factors provided in IPPC Regulatory Guidance Series No1, The Determination and Implications of “Change in Operation” and “Substantial Change” under IPPC (Reference 10).

    - Site Restoration and Decommissioning

    This is not considered as a separate environmental consideration within the H1 methodology. The requirements for site restoration are provided in the Sector Guidance notes. As the aim of the IPPC is that detriment to the site will be prevented throughout operation of the site, this requirement should be met regardless of the activities and environmental protection options chosen.

Estimating concentrations in receiving media

2. The method used for quantifying the local effects of emissions to air and water, is to estimate the concentration of emitted substances after dispersion into the receiving environmental media (Reference 13). Calculation of this so-called "process contribution" (PC) of a substance emitted from the activities is achieved most accurately by the use of mathematical air and water dispersion models, which take into account relevant parameters of the release and surrounding conditions. Such models require a degree of expertise and resources to carry out, and may not be justified if the emission results in negligible environmental impact.

The Agency has, therefore, developed simplified calculation methods, without the need for detailed modelling, to estimate the predicted concentration of substances after dispersion into receiving media. These methods assume "worst case" situations and tend to result in an overestimation of the potential effects. Further, more accurate calculations, may be carried out at a later stage if, on the basis of the simplified calculations, the emission is likely to represent a relatively high risk of environmental impact.

Screening of insignificant emissions

3. Typically, processes regulated under IPPC will result in the release of a number of polluting substances for which process contributions expressed as concentrations in the receiving media need to be calculated. However, in general terms it is unlikely that the release of a very small quantity of a pollutant will lead to significant environmental effects. Under these circumstances substantial expenditure of resources on environmental assessment is not warranted, provided that there is sufficient confidence that no significant risk to the environment has been overlooked. Therefore, it is proposed that an initial step can be used to screen out those emissions that do not require further assessment because they are judged unlikely to pose a risk to the environment.

To assist in this judgement, criteria are proposed in this guidance for deciding when a release of a substance into air or water could make a contribution that would justify further evaluation of its environmental impacts.

The approach taken to identify these priority emissions is to compare the estimated process contribution (PC) of the emission against the environmental benchmark for that substance in the relevant environmental medium. Emissions with process contributions that exceed the relevant criterion are considered to warrant further investigation of their potential environmental effects. Conversely, emissions that fall below the threshold can be screened from the assessment process as their contribution is so small that they are unlikely to influence BAT decisions.

Screening criteria are provided in the following sub-sections for short term and long term releases for air and water. These are set at a small percentage of the relevant environmental benchmark such that, even in cases where the existing environmental concentration of a substance already exceeds the relevant benchmark, any additional small contribution from the process is unlikely to have a significant effect.

interpretation of "insignificant" in relation to environmental impact

Note that if an emission is *not* screened out using this test, it does not necessarily follow that it will have a *significant effect*, or that it will result in an adverse environmental impact. **Such a judgement can only be made by consideration of the total concentration of a substance (ie including the existing background contribution from other sources) in relation to an environmental benchmark, and is carried out as a subsequent step of this methodology. For many well-managed industrial processes the contribution from the installation is often an order of magnitude below benchmarks established for the protection of the environment.**

It should also be noted that the method for estimating process contributions adopts a precautionary approach, in that the assumption of worst case conditions throughout tends to result in process contributions that are an overestimate of the actual contributions.

Note that a substance could exceed the screening criterion for one medium but not for another, or exceed the screening criterion with respect to long term effects but not short term, and vice versa.

Releases that fall below the screening threshold do not require any further impact assessment within this methodology. However, the Operator should still have regard to BAT for the prevention or control of all emissions, and ensure that techniques are employed where costs are reasonable to do so.

Case for detailed modellng of the fate of emissions

4. The simple calculation methods used to estimate process contributions (PC), as described in note 2, have been developed primarily for screening purposes and for estimating process contributions where environmental consequences are relatively low. They do not take into account all the parameters that may influence dispersion of substances to air, dilution in surface water or deposition from air to land. Although the methods adopt a precautionary approach by assuming

"worst case" parameters and environmental conditions, it is possible for large errors to occur and this risk should be taken into account in the methodology.

Therefore, depending on the potential influence of the margin for error, in certain cases it will be desirable to model the releases in greater detail to provide more accurate information. It is typical to find that only one or two releases need such an assessment, but this will depend on the technology, the existing air and water quality and the performance of the control techniques proposed for the options being assessed.

Significant expertise and resources may be needed to conduct detailed modelling of the fate of releases. Where the risk to the environment is low, such expenditure is not usually warranted. Therefore, the Agencies propose guidelines in this module to assist the Operator in reaching a reasoned judgement of the need to conduct detailed modelling, based on the following factors:

- the potential error in estimating process contributions and in monitoring of ambient background environmental quality
- the existing background environmental quality
- the presence of sensitive receptors.

These guidelines are discussed further in the module.

Use of environmental benchmarks

5. Environmental benchmarks are used in this methodology as an indicator of a degree of environmental impact that can be considered acceptable for a particular substance to a receptor or environmental medium. There is a considerable amount of laboratory and field-based data on the sensitivity of individual receptors to particular pollutants. This type of information has formed the basis for the development of environmental quality objectives and standards, such as those used to control releases to water and air. Environmental Quality Standards (EQS) are prescribed for certain substances and are used to define the upper bound of a concentration of substance in the environment that is considered tolerable.

At present, statutory EQS exist only for a limited number of substances. However, the Agency has derived provisional benchmarks for substances released to each environmental medium from a variety of published UK and international sources. These are known as "Environmental Assessment Levels" (EALs) and are listed in Appendix D.

The methodology for the derivation of the existing Environmental Assessment Levels is given in Appendix D.[4]

For some substances with persistent, bioaccumulative or highly toxic effects, it is difficult to establish thresholds below which it could be considered "no harm" takes place. In these cases, the Operator should take a more precautionary approach to the prevention and control of the substance, and the substances should be given greater priority when considering the relative environmental risk between options. Further advice should be sought from the Regulators regarding the scope and detail of risk assessment for these substances.

Whilst methods are available to derive acceptability thresholds for certain substances in relation to direct impacts on a particular receptor, for several of the environmental effects listed here, there is no easy definition of acceptable impact. This is the case for effects such as global warming, photochemical ozone creation and waste hazard and disposal. In these cases, the assessment methods are based on relative "burdens" and acceptability thresholds are not included in the methodology.

---

[4] The Environment Agency is preparing a consultation document for the proposed revision of the methodology for determining Environmental Assessment levels in future. Subject to consultation, adoption of the revised methodology will aim to improve the consistency by which EALs are derived for human and ecological protection across all environmental media.

MODULE 3
QUANTIFY IMPACTS

3.1 *Identify Environmental Impacts that are Relevant to the Assessment*

Aim

The aim of this section is to enable the Operator to simplify the procedure by screening out any impacts which will clearly be unaffected by the existing or proposed activities.

For example, if the activities do not result in releases to water under any circumstances, the Operator should state this as the reason why consideration of this impact does not need to be made in the assessment. **If there is any doubt whether an impact may be relevant then they should not be screened here, but the judgement made after consideration of further detail provided for that particular impact later in the methodology.**

1. **Identify which of the following environmental impacts are relevant to the assessment** by completing the following table, which is available in the software tool. If any are not relevant, provide a brief justification why this is the case.

impact	Relevant Yes/No	Describe the pathway and receptor where relevant, or state the reason why not relevant
emissions to air		
emissions to surface water		
deposition from air to land (note 1) noise & vibration (note 2)		
odour (note 2)		
risk of accidents & their consequences (note 2)		
visual impacts associated with operation of the installation		
global warming (inc. energy use)		
ozone creation		
waste treatment and disposal		

Notes

1. In most IPPC activities direct emissions to land should be completely avoided through the application of preventative measures. In cases where direct releases are unavoidable, e.g. soakaways, there are specific requirements, which must be met. All PPC installations, whether or not they include direct releases to land, must demonstrate compliance with the requirements of the Groundwater Regulations as part of the application requirements. These requirements are described in IPPC Sector Guidance Notes. More detailed guidance on risk assessment may also be provided in the IPPC Sector Guidance Notes for activities where direct releases are unavoidable, such as in the landfill and intensive livestock sectors.

   Further assessment of groundwater is not required as part of the H1 methodology for environmental assessment or BAT appraisal purposes as the information provided to demonstrate compliance with the above requirements already covers this issue.

2. If you are using H1 to conduct an **ENVIRONMENTAL ASSESSMENT** of the installation as a whole, the assessment of noise and odour impacts, and the consequences of accidents should be carried out by following the requirements in the relevant sections of the Sector guidance and completing the appropriate sections of the application. For **OPTIONS APPRAISAL** however, you should use the simplified methodologies described in this module.

3.2 Describe the Quality of the Local Environment

Aim

Local factors, such as proximity to particularly sensitive receptors, existing air quality, water quality and water resources can have a significant influence on the techniques and options available and level of pollution control required from the activity. The aim of this section is to identify whether there are any local sensitivities to emissions from the activities, although at this stage only a qualitative response is needed. Further investigation may be carried out late in the methodology depending on the magnitude of risk to the receiving environment.

It is recommended that the Operator discuss relevant local considerations with the local Regulator before proceeding with detailed project development and environmental assessment.

1. **Provide a general description of the nature of receptors and quality of the local environment into which polluting emissions are received**(note1). This table can be filled in using the electronic template and supplemented with further information (e.g. location maps) where appropriate.

Local Factor		**Response**
Air Quality	Are there any Environmental Quality Standards relating to substances released from the activities, which may be at risk due to additional contribution from the activity? (Environmental Quality Standards for air and water are described in IPPC Sector Guidance Notes)	
	Are there any Local Air Quality Management Plans applicable to releases from the activity?	
Water Quality & Resources	Are there any Environmental Quality Standards relating to substances released from the activities, which may be at risk due to additional contribution from the activity?	
	Have any proposals to abstract water been assessed as satisfactory to obtain an abstraction licence?	
	Is the activity located in a groundwater vulnerable zone (for activities with direct releases to land only)?	
Proximity to Sensitive Receptors	Are there any sensitive groups of population, e.g. schools or hospitals?	
	Is public nuisance likely to be an issue for noise, odour or plume visibility?	
	Are there any sensitive agricultural areas or wildlife habitats, e.g. Special Areas of Conservation, or Special Protection Areas, likely to be affected by releases from the activity? (Description of requirements of Habitats Directive is provided in IPPC Technical Guidance Notes)	

Notes

1. The Operator may obtain information on the quality of the local environment from the local Regulator's Offices, Local Authorities or other sources as described in the supplementary note "Ambient Data" (see Reference 12).

3.3 Quantify Impacts of Emissions to Air

Aim

The aim of this section is to assess the direct impacts of substances released to air on human and ecological receptors.

This is done by estimating the concentration of each substance as dispersed into air and comparing it against the appropriate environmental benchmark concentration.

3.3.1 Calculate Process Contributions of Emissions to AIr

1. **Estimate both the long term and short term Process Contributions (PC)** (note 1) **of all substances released to air**, using the following simplified calculation method. Data may be entered into the H1 software tool, which performs the calculations. **Note: If you already have detailed dispersion modelling data available that is valid for the activities in the assessment, then the process contribution derived from modelling should be used instead of the method below.** The Operator should identify where this is the case by inputting the modelled data into the software as prompted.

   Where detailed modelled data is not available, estimate the process contribution using the formula below:

   $$PC_{air} = DF \text{ x } RR$$

   where:

   PC = process contribution ($\mu g/m3$)

   RR = release rate of substance in g/s, (see inventory of emissions in module 2).

   DF = dispersion factor, expressed as the maximum average ground level concentration per unit mass release rate ($\mu g/m^3/g/s$), based on annual average for long term releases and hourly average for short term releases (note 2)**. A table of dispersion factors is provided below.**

Effective height of release (see Module 2) (m)	Dispersion Factor ($\mu g/m^3/g/s$)	
	long term: maximum annual average	short term: maximum hourly average
0	148	3900
10	32	580
20	4.6	161
30	1.7	77
50	0.52	31
70	0.24	16
100	0.11	8.6
150	0.048	4.0
200	0.023	2.3

   Note that these factors are already built into the software tool and are shown here for general reference. Linear interpolation is recommended for stacks of different height than those given in the table.

2. **Provide a summary of long-term and short-term predicted concentrations of substances. Where there is more that one release point, the PCs for each substance should be shown for each release point and also added together to calculate the total PC for the activities for that substance.** Adding the PCs from all release points assumes a worst case situation which will tend to overestimation of the actual contribution. However, this is consistent with the precautionary approach of the initial screening process. Note that if subsequent modelling analysis is carried out in response to section 3.3.3 then a single, more accurate PC should be obtained.

Notes

1. Different process options may lead to variations on the pattern of releases. For example, a process operated intermittently may give lower annual concentrations compared to one run

continuously but an increased frequency of short-term peaks may be the result. Furthermore, although the long-term average concentration may have been rendered acceptable by generally good dispersion there may, on occasions, be unacceptable short term peaks.

Environmental benchmarks for both long-term and short-term effects in the receiving environment are available. Long-term effects may relate to those substances that are released continuously, frequently or over relatively long time periods. Short-term effects may relate to peak concentrations, intermittent or periodic emissions that occur over short time periods. Both long term and short term effects of releases should be considered in the assessment, according to the pattern of releases from the activities. It is also important, particularly with short term concentrations, that they are calculated on the same basis as corresponding environmental benchmarks e.g. over the same averaging period or percentile exceedence.

2. The dispersion factors for long term and short-term releases assume "worst case" conditions. The factors are derived from a mathematical dispersion model and are presented as maximum average ground level concentrations for unit mass emission rates, at different effective stack heights. Note that as these factors assume worst case dispersion conditions, with no allowance is made for thermal or momentum plume rise, the process contributions calculated are likely to be an overestimate of the actual concentrations

   For long-term releases the dispersion factors are presented as maximum annual averages, and for short-term releases, as maximum hourly averages. The factors for long term emissions are calculated using ADMS3, a roughness length of 0.1m. Short-term factors are also calculated with ADMS3 and roughness length 0.1m. For releases at ground level, meteorological conditions corresponding to PG Class F are used, and Class B for releases above ground level.

3.3.2 Screen out Insignificant Emissions to Air

Identify the emissions that warrant further investigation of their impacts, by screening out those which are emitted in such small quantities that they are unlikely to cause a significant impact on the receiving environment. This is done using the method below:

1. Compare the short-term and long-term process contributions (PC) of substances emitted to air against the relevant short term and long term environmental benchmarks for emissions to air $^{(note\ 1)}$ provided in Appendix D.
2. Identify which emissions warrant further assessment by applying the criteria below:

   $PC_{long\ term}$ > 1% of the long term environmental benchmark$^{\mathbf{(note2)}}$

   $PC_{short\ term}$ > 10% of the short term environmental benchmark$^{\mathbf{(note\ 3)}}$

   Ensure that the same statistical basis for mass concentration as the environmental benchmarks is used.$^{\mathbf{(note\ 4)}}$
3. The calculations can be performed by the software tool and presented as a summary of the following information:
   - short-term and long-term benchmarks for each substance
   - process contribution of short-term and long-term emissions
   - process contribution as a percentage of the relevant benchmark
   - identification of insignificant emissions

Notes

1. The most appropriate environmental benchmark should be selected for each substance, depending on local circumstances. Most of the environmental benchmarks available for releases to air are based on occupational exposure data for human receptors. There are, in addition, a few benchmarks derived for critical levels for sensitive vegetation. All available benchmarks for emissions to air are listed in Appendix D. Further guidance on the derivation and selection of benchmarks is also provided in Appendix D.

   For groups of pollutants that have not been characterised, e.g. VOCs (volatile organic compounds) or metals, the most stringent benchmark should be applied as a precautionary approach. If necessary, the Operator may decide to further characterise the emissions in order to apply the specific benchmarks according to the composition of the release.
2. The criterion for screening long term emissions that are unlikely to lead to significant environmental impacts is proposed as 1% of the relevant EQS or EAL. This is based on judgement of the level at which it is unlikely that an emission will make a significant contribution to

any impact even if a EQS or EAL is exceeded. For long-term releases, it is usually the existing background concentration of a substance that dominates, rather than the long-term process contribution. As the proposed 1% criterion is two orders of magnitude below the EQS or EAL that represents maximum acceptable concentration for the protection of the environment, a substantial safety factor is built in. Even if the existing ambient quality meant that an EQS or other benchmark was already at risk due to releases from other sources, a contribution from the process of less that 1% (which is in itself likely to be an overestimate) would be only a small proportion of the total.

It should be noted also that the selection of this criterion is to a certain extent pragmatic, based on experience of environmental assessments undertaken under the IPC regime.

3. The criterion for screening short-term emissions that are unlikely to lead to significant environmental impacts is proposed as 20% of the relevant short-term benchmark. Here, the assumption is that for short term releases, differences in spatial and temporal conditions mean that the process contributions themselves are more likely to dominate and not the ambient environmental concentrations. If a maximum error factor of 10 is assumed for the estimation of short-term contributions, it suggested that those emissions below 100% of the short term EAL are unlikely to lead to breaches of a short-term benchmark.

4. Benchmarks, particularly those for statutory EQS, are often expressed on different time bases. Conversion factors for different averaging times are provided below:

Conversion factors for Different Averaging Periods (see Reference 14)

From To ⇨ ⇩	15 minutes	1 hour	8 hours	24 hours
1 hour	1.34	1	0.7	0.59

3.3.3 Identify Need for Detailed Modelling of Emissions to Air

The Operator should determine whether detailed dispersion modelling of any of the emissions not screened out in the previous step should be undertaken, in order to obtain more accurate estimates of process contributions than those obtained through using simplified calculation methods in Section 3.3.1. This more detailed assessment requires specific expertise and is usually applied in situations where there is a potential risk of breaching an environmental benchmark. The Operator should make a judgement of this potential risk by taking into account the guidelines below, and presenting a decision on whether more detailed modelling will be undertaken. (note 1)

1. **Identify whether any emissions require detailed modelling, taking the following guidelines into account:**

   Long Term Effects

   - Obtain information on the long-term ambient concentrations for releases to air (note 2). Then calculate the total predicted environmental concentration (PEC) of that substance by summing the background concentration and the process contribution.

     $$PEC_{air} = PC_{air} + \text{background concentration}_{air}$$

   - Modelling of long-term effects may be appropriate if the long-term PEC is above 70% of the relevant environmental benchmark (EQS or EAL), or in locations where there is an Air Quality Management Plan for a substance emitted by any of the options. (note 3)

   Short Term Effects

   - Modelling of short term effects may be appropriate if the short-term PC is more than 20% of the difference between the (long term) background concentration(note 5) and the relevant short term environmental benchmark (EQS or EAL) (note 5)

   Sensitive Receptors

   - If there are any local receptors which are sensitive to any of the emissions that have not been screened out, then modelling of long-term and short-term effects may be needed.(note 6)

   Small point sources

   - For gas and distillate oil-fired boilers with an aggregated thermal input less than 20MW, modelling may not be needed provided that the discharge conditions meet the requirements of Technical Guidance Note D1 (ref 13).(note 7)
   - For other small point sources such as vents and short stacks, a case may be made by the Operator that the scale of the release does not warrant detailed modelling on the basis of limited environmental risk. This should be done preferably in discussion with the Regulator.

2. Summarise the above information and provide a reasoned judgement to support the decision whether or not to conduct detailed modelling.

3. Describe the methods and assumptions used to carry out further dispersion modelling for those releases identified above(note 8), and revise the process contributions according to the data obtained from detailed modelling.

The H1 software tool can be used to summarise the supporting information, by substance and option, but the Operator should also provide information on the decision-making process as indicated in the software. This would usually be submitted as a separate report.

Notes

1. The suggested guidelines provided below should not be used in a prescriptive manner, but to guide the Operator in reaching a reasoned judgement of the need to conduct detailed modelling. It is relevant to consider all of the factors described below in reaching this decision. It is recommended that the guidelines are not considered as individual absolute thresholds, but that a combined view is taken to judge whether there are sufficient grounds to warrant more detailed study of the fate of the releases.

2. Information on the existing background concentrations of releases to air may be obtained from various sources as described in the Ambient Data Guidance (see Reference 12).

   The Operator should provide information on the location and measurement basis of the background data, ensuring that the same statistical basis has been used for the calculation of values for PC as for information on background concentrations.

   It could be argued that for existing processes, the measurement of the background concentration already includes the contribution from the process to some extent. However, it is likely that the full contribution will not be taken into account, as the point that ambient monitoring data is measured is unlikely to coincide with the point at which the maximum ground level concentration of the release from the process occurs. Therefore, for the purposes of simplification, it is assumed that the process contribution is additive to the ambient level, which is the precautionary approach.

3. For long-term releases the risk of breaching an EQS or EAL is usually dominated by the background concentration rather than the process contribution. Where analysis of ambient environmental quality for air indicates that the background level is already high for a substance released from the installation, there is a risk that the additional contribution from an individual installation may result in a breach of an environmental benchmark. A high level may be considered to be where the predicted environmental concentration is 70% or more of the appropriate environmental benchmark (EAL or EQS), or where an Air Quality Management Plan (AQMP) is in place for a particular substance. This criterion is based on a possible margin of error in monitoring background data in the region of ±50%.

4. Detailed assessment of short-term effects is often complex. The maximum process contribution and maximum background concentration may be separated both temporally and spatially, such that the addition of the two “worst case” short-term concentrations together does not represent a likely occurrence. The error in estimating short-term releases can also be a factor of 4 to 5. Therefore, a pragmatic approach is suggested that unless the short-term PC exceeds 30% of the short term EAL then the emissions may be considered to be tolerable and, subject to note 5, detailed modelling may not be needed.

   Note that the background concentration in the case of assessing short term effects is assumed to be twice the long term ambient concentration.

5. The Operator should also consider whether the presence of particular local receptors justifies a need for detailed dispersion modelling to be carried out, such as:

   - any human population (e.g. schools, hospitals or neighbouring properties)
   - a site of special scientific interest (SSSI) (or ASSI in Northern Ireland), a special protection area (SPA) or a special area of conservation (SAC) within 10km of the location of the installation (or 15km for major emitters identified by the Regulators such as large power stations, refineries or iron and steelworks);
   - a groundwater vulnerable zone;
   - other exceptional concerns.

   Information on the location of these sites can be obtained from various sources, including Ambient Data (see Reference 12).

6. Combustion plant with a thermal input less than 20MW are only covered by the Pollution Prevention and Control Regulations if they are an associated activity to any of the activities in Schedule 1 of these Regulations. As stand-alone units, they are not considered to be major sources of pollution, but are subject to the requirements of the Clean Air Act. Whilst it is important that the environmental impact of these sources is estimated, it is considered that the risk from these sources will not often warrant detailed dispersion modelling to be undertaken as part of this assessment, provided that the basic requirements for adequate dispersion as detailed in D1 are met.

   Where an Operator has combustion plant with an aggregated thermal input of less than 20MW, it is recommended that they discuss with the Regulator whether modelling is justified. This will usually be based on consideration of the local geographical situation and local environmental quality.

7. Some guidelines for reporting on Air Dispersion Modelling are provided in Appendix E. These are based on the Environment Agency’s internal document “Work Instructions for Air Dispersion Modelling” produced by the Agency’s Air Quality Modelling Assessment Unit (AQMAU). Operators in Scotland or Northern Ireland may seek similar advice from the local Regulators. In addition, where there is a local sensitive receptor, the Operator should seek further advice from the Regulator regarding the scope and detail of further assessment.

   Note that for certain industrial sectors there may be sector-specific protocols and codes of practice that may be used. Contact the local Regulator for further information.

3.3.4 Assess Acceptability against Local Environmental Quality Requirements

1. **Check whether the emissions of substances from the proposed options are acceptable in relation to the existing local air quality and any statutory requirements.**(note 1) This should be done for long-term emissions by comparing the long-term Predicted Environmental Concentration of each substance released to air (see Section 3.3.3) with the corresponding long-term EAL or EQS for that substance. For short-term emissions the PEC should be calculated by adding the short-term Process contribution to twice the long-term ambient concentration and then the PEC should be compared with the short term EAL or EQS.(note 2)
2. Identify any releases where the EAL or EQS is already exceeded, or where the contribution from the installation will result in the EAL or EQS being exceeded. **Such options are unlikely to be considered acceptable and should normally be ruled out of further consideration in this appraisal. (note 3)**

   The Operator should provide a qualitative response to this assessment, as indicated in the software tool.

Notes

1. Environmental Quality Standards (EQSs) and Environmental Assessment Levels (EALs) are benchmarks of environmental impact or harm. In assessing the impact of an installation against these benchmarks, consideration of the background contribution from other pollution sources should be taken into account. If a release from an IPPC installation constitutes a major proportion of an EQS or EAL, or makes a major contribution to the breach of an EQS or EAL, then this may not be judged to be acceptable.

   Benchmarks for air are available both for human health and for ecological receptors. The Operator should select the benchmark which is most applicable to the situation.

   Environmental Quality Standards may be set by the European Community or nationally. Further conditions are attached to EQS when applied as statutory requirements than in their use as benchmarks in the H1 methodology. **In assessing whether the emissions from the activities comply with these standards, reference should be made to the exact conditions under which the standards apply (see** Table D1 **for air quality standards).**
2. Detailed assessment of short-term effects is often complex as the maximum process contribution and maximum background concentration may be separated both temporally and spatially, such that the addition of the two “worst case” concentrations together may not represent a likely event. A pragmatic approach is suggested which compares the sum of the short-term process contribution added to the background concentration (assumed in this case to be twice the long term background concentration), to the relevant short term EAL. This is considered to represent a more likely situation.
3. The Regulations require that the effects of compliance with any environmental quality standards (EQSs) should be considered within any assessment of BAT, and also as part of the environmental impact assessment for the installation as a whole. In certain cases, it may be considered that further pollution control techniques, at higher cost, are justified as BAT in order to preserve the quality of the local environment.

   If an EU EQS is already exceeded, or may be exceeded as a result of an additional contribution from an IPPC activity, consideration of further control measures needs to be taken. This should take into account the practicality and reasonableness of going beyond indicative BAT, based on the contribution that the installation makes toward the problem and the likelihood of remedial action elsewhere. Where a new installation would only make a minor contribution to a breach, it will normally be more desirable for Regulators (and Local Authorities where relevant) to consider controls on other major sources of pollution rather than imposing excessive costs or refusing a Permit. National EQSs do not have the same legal status as EU EQSs, and there is no explicit requirement to impose stricter conditions than indicative BAT in order to comply with a national EQS. However, national EQSs are a benchmark for harm and any significant contribution to a breach is likely to be unacceptable.

   Community and National EQSs exist only for a limited number of substances emitted to air and water. However, provisional benchmarks have been derived for substances released to each environmental medium from a variety of published UK and international sources, known as “Environmental Assessment Levels” (EALs). Although these do not carry any statutory basis, they are, again, a benchmark for harm against which any exceedance should be viewed as unacceptable.

3.3.5 Summarise the Impact of Emissions to Air

1. **For each option, list all substances emitted to air that have not been screened as insignificant in Section 3.3.2.** This should be done for long-term emissions only.(note 1) Where there are no emissions to air for any or all of the options, the Operator should state that this is the case.

2. **Normalise the process contribution (PC) of each substance (calculated in Section 3.3.1) against the appropriate environmental benchmark (EQS or EAL) (note 2) for that substance, according to the formula below.**(note 3) The resulting figure is known as the environmental quotient (EQ).

$$\mathbf{EQ_{(Substance)}} = \frac{\textbf{Process Contribution }(\mathbf{PC_{substance}})}{\mathbf{EAL_{substance}}}$$

3. **Sum the environmental quotients to provide total impact of emissions to air for each option**. If the environmental benchmarks used for normalisation are derived on the same basis (eg. protection of human health), then the environmental quotients (EQ) can be added to obtain a cumulative total impact. i.e.

$$\mathbf{EQ_{air}} = \mathbf{EQ_{substance\ 1}} + \mathbf{EQ_{substance\ 2}} + \ldots\ldots.$$

The H1 software tool can be used to perform the calculations and present the information as histograms.

Notes

1. Short-term effects are determined primarily to assess whether options are acceptable. It is more appropriate to use long term effects to compare relative environmental impact between options. The weight that short term effects should play in the final ranking of options and selection of BAT should be commensurate with the importance of the effects. The operator should justify this as part of the decision-making process in module 4.

2. The Operator should select the environmental benchmark based on the most appropriate receptor. Environmental benchmarks (EALs and EQSs) for a wide range of substances emitted to air are given in Appendix D. These have been derived on the basis of protection of population. In addition, if there are any potentially sensitive receptors within a 10km range of impact of the installation (or 15km for a coal fired power station), which have been designated on the basis of vegetation, then the benchmarks for SO_2 and NOx given in Table D2 of Appendix D should be applied.

3. The direct environmental effect of a substance released to a particular environmental medium can be normalised as the ratio of the process contribution to the EAL for that substance. This quantity is denoted the environmental quotient (EQ). This enables the relative impact of substances to be directly compared between options.

These indicators do not provide a completely scientifically accurate assessment of the effects of the releases on the environment. They are based, for example, on assumptions that effects are linearly proportional to the concentration of a substance in the environmental medium into which it is released; that the EALs correspond to identical levels of effect for all substances and all media; and that there are no synergistic or antagonistic effects between substances. However, for the purposes of comparing control options at a particular location, where the nature of the receiving environment will be effectively the same for all options, the Environmental Quotients provide simple, robust indicators of relative impacts which are considered sufficient for the majority of applications.

3.4 Quantify Impacts of Emissions Deposited from Air to Land

Aim

The aim of this section is to assess the impact of substances deposited to land via air emissions (note 1).

The method proposed below is an interim method (note 2) which consists of two stages:

- qualitative and quantitative screening guidelines, to identify emissions that present a potential risk of environmental impact; followed by
- guidelines for the assessment of those emissions, to estimate their potential effects.

Notes

1. For the majority of industrial activities, direct releases of polluting substances to land should be avoided by the use of appropriate preventative techniques. There are certain activities covered by the PPC Regulations where direct releases are unavoidable, such as slurry spreading in the intensive livestock sector and landfill operations. In these cases, other risk assessment guidance more appropriate to the consideration of direct releases from these specific activities is identified in the relevant IPPC Sector Guidance Note. The assessment of impacts to land in the H1 guidance considers only those substances that are deposited to land via air emissions.

2. An alternative method for assessment of deposition would be to estimate deposition rates and compare these with maximum deposition rates for the protection of soils. However, the Regulators consider that there is insufficient information available to date to enable robust maximum deposition rates to be generated, except for a few substances. Setting environmental criteria for soils is a complex process, which involves a number of factors, including soil type, potential land use and underlying geology. Where this has been undertaken in any detail, for example, in establishing critical loads for sulphur and nitrogen then this has taken many years of scientific effort over a considerable period of time. There are no Environmental Quality Standards in the UK for releases to land by deposition and very little information is available to date from any source on suitable benchmarks.

   The development of a more robust suite of environmental benchmarks is being given high priority within the EA's research programme[5]. However, the subsequent determination of benchmarks for land using the new method will itself be an ongoing programme of work, and it may be several years before work to derive a suite of benchmarks can be completed. The extent of substances covered will also be determined by data availability.

   In the interim, it is proposed to use the method described below.

3.4.1 Screen out Emissions to Air that are Insignificant when Deposited to Land

1. **Identify those substances released to air that warrant further investigation of deposition impacts, using the following guidelines.** All other emissions to air can be screened from further assessment as they can be considered to be unlikely to cause an impact from deposition.

   - Substances that are highly toxic, bioaccumulative or persistent should be investigated further. An indicative list is provided in Appendix D, Table D7. (note 1)
   - Emissions that contribute to acidification and eutrophication effects should be further investigated, where these are released by the installation in substantial quantities. (note 2)
   - For substances where a maximum deposition rate (MDR) is available (see Table D7), emissions that result in a process contribution (PC) that is greater than 1% of the MDR should be further investigated. The calculation below can be used to estimate PC_{ground}.

$$PC_{ground} = \frac{(PC_{air} \times RR\ x\ DV \times 3 \times 86400)}{1000}$$

continued….

---

[5] A methodology for derivation of benchmarks for the protection of land has been proposed in recent work conducted for the Agency.

Where:

PC_{ground} = process contribution to daily deposition rate (mg/m^2/day)
RR = release rate (g/s)
DV = deposition velocity (taken to be 0.01m/s) (note 3)
The value of 3 is a nominal factor to convert dry deposition to total deposition and the value 86,400 is a correction factor from days to seconds.
PC_{air} = Process contribution to air, based on maximum annual average ground level concentration for unit mass release rate (µg/m^3/g/s). Deposition from air to land is a long-term effect and values should be taken from those derived in section 3.3.1 or from detailed dispersion models.

- For substances where no maximum deposition rate is available, emissions that result in a process contribution (PC) that is greater than 1% of the long term EAL or EQS to air should be considered for further investigation. (note 4)
- Emissions that may have an effect on sensitive receptors within 10km of the installation should be considered for further investigation.

Notes

1. The assessment of impact on soils should include the nature of the substance deposited; its effects and the degree to which it can be broken down. Higher risk emissions include substances with toxic effects or those that are not readily degraded.
2. Certain substances released to air result in acidification and eutrophication effects as they are deposited to land. These effects are usually a result of long-range transport of pollutants and there are several measures proposed which are intended to reduce these impacts: The National Emissions Ceilings Directive, the Large Combustion Plant Directive and the Directive on Sulphur Content of Liquid Fuels. The main industrial contributions are from large point sources such as power stations, refineries and integrated iron and steelworks. Operators of these major emitters should consult the Regulator over the circumstances when such effects might need to be determined and how to quantify and present any such effects. For most other IPPC activities the contribution to these effects can generally be considered negligible.
3. Dry deposition is affected by a number of factors including the characteristics of the atmosphere, the nature of the receiving surface and depositing material. The resistance to transfer from the atmosphere to receiving surface in the lowest layers of the atmosphere imposes an upper limit on the value of the deposition velocity. In stable conditions this is 0.01m/s [ref Jones, 1983] and this value could be used to calculate the predicted concentration. A deposition velocity of this magnitude is generally appropriate for particles of less than 10mm and will be conservative for particles smaller than this.
4. EALs and EQSs for air cannot be assumed to be directly protective of soils as the receptor and nature of effects may be different. However, the purpose of this guideline is to provide a general screen for those emissions that are released in small quantities.

   If detailed modelling of emissions was conducted as part of the assessment of releases to air, then the results of this modelling should be used.

3.4.2 Conduct Risk Assessment of Impacts

1. **Where the emissions have not been screened as insignificant, the Operator should provide a further assessment of the potential effects of deposition of the substance in the local surroundings.**

   This should include the following:

   - Identification of potentially vulnerable or sensitive receptors eg human and animal health, soils systems and habitats.
   - Further modelling of the deposition (where not already conducted as part of modelling of air dispersion) and loading over annual and longer term periods.
   - Assessment of the persistence of the substance, e.g. biodegradability, conversion, retention and mobility in soil.
   - Assessment of the acidification, eutrophication (where relevant) and toxicity effects.
   - Acceptability of the effects against benchmarks (where available – see section 3.4.1 and note 1).
   - Where options appraisal is undertaken, a comparison and ranking of the options in terms of potential environmental impact.

   The Operator should seek further advice from the Regulator regarding the scope and detail of such an assessment, as this is likely to be location specific.

2. **The results of such an assessment would usually be submitted as a separate report.** The document reference for this can be provided in the H1 software tool as prompted.

Notes

1. Where benchmarks or guideline values are available for the protection of certain receptors from substances deposited from air to land, these may be used where appropriate. For example, those provided in appendix D, table D7.

3.5 Quantify Impacts of Emissions to Surface Water

The aim of this section is to quantify the impacts of substances and effluent released to surface water$^{(note\ 1)}$.

There are two methods that are proposed for the quantification of impacts in surface water:

- Chemical specific
- Direct Toxicity Assessment (DTA)

The method described in the following sections is based on chemical specific assessment, which is appropriate in situations where the chemical composition of the effluent is known (Reference 11). For highly complex discharges it may be more appropriate to use DTA. Further guidance on the use of DTA is given in Appendix F and in IPPC Sector Guidance Notes, where relevant.

You should complete the relevant section according to whether the emissions are released to:

- River
- Estuary
- Coastal waters

and also taking into account whether the final discharge is via sewage treatment works.

Notes

1. The method does not include assessment of direct or fugitive releases to groundwater, as in the majority of PPC applications these will be avoided through preventative techniques. All PPC Applicants are required in any case to demonstrate compliance with the Groundwater Regulations as part of the PPC application, as described in Section 2.4 of Sector Guidance Notes. This should be conducted as a separate exercise to this assessment.

3.5.1 Calculate Process Contribution of Substances Discharged to Sewer

1. **Estimate the corrected release rate of substances discharged to sewer**, taking into account any further reduction taking place in the sewage treatment works.$^{(note\ 1)}$ This can be estimated from:

$$RC_{corr} = RC_{act} \times STRF$$

where:

RC_{corr} = corrected release concentration allowing for any attenuation of pollutant during sewage treatment (mg/l)

RC_{act} = actual release rate of pollutants discharged to sewer (mg/l)

STRF = sewage treatment reduction factor representing the remaining proportion of the pollutant in the effluent following treatment.$^{(note\ 2)}$ Values for the sewage treatment reduction factor, STRF should be selected from the Table below, or where Operators have access to specific data regarding attenuation this may be used. In the latter case, the Operator should also provide details of the derivation of the attenuation factors used.

Substance	**sewage treatment reduction factor (STRF)**
Substances not attenuated during sewage treatment (e.g. Cl, K, Na)	1 (i.e. no reduction)
other pollutants (e.g. biodegradable organics, insoluble metals)	0.6

2. **The H1 software tool can be used to calculate and present this information.** This information should then be used in one of the following sections, depending on the final point of discharge from the sewage treatment works.

Notes

1. Where a release takes place first to sewer and is then treated at a sewage treatment works, the release rate can be modified to take account of pollutants removed during treatment. The pollutant may undergo physical, chemical and biological changes, which affect its form and concentration in the effluent and subsequent environmental impact on the receiving water. The extent of removal during sewage treatment will depend on the interaction between the properties of the substance, the degree of treatment and operational characteristics of the works.

2. Apart from some highly soluble ionic species, removal efficiencies are only occasionally less than 40% and often greater than 80-90%.
3. It can be assumed that temperature and pH of releases to sewer do not need to be further assessed at the final point of discharge.

3.5.2 Calculate Process Contribution of Substances Released to Rivers

1. **Calculate the process contribution of substances released to inland rivers from:**

$$PC_{water} = \frac{(EFR \times RC)}{(EFR + RFR)} \times 1000$$

where:

PC = process contribution (µg/l)

EFR = effluent flow rate (m^3/s)

RC = release concentration; concentration of the pollutant in the effluent (note 1) (mg/l)

RFR = river flow rate (m^3/s).(note 2)

Note: If you already have detailed dispersion/dilution modelling data available that is valid for the activities in the assessment, then this should be used to derive the appropriate process contribution instead of the method above. The Operator should identify where this is the case by inputting the modelled data into the software as prompted.

2. **Provide a summary table of the process contribution of releases to water for each option.** (note 3) The H1 software tool may be used to calculate and present this information.

Notes

1. Where a release takes place to sewer and is then treated at an inland sewage treatment works, the release concentration (RC) should be modified by the factor calculated in Section 3.3.1 above. Note that where water is abstracted from non-mains supply, it is any additional *increase* in emission concentration for a given substance over the background level, which should be used to calculate the environmental impact in this methodology.
2. Site specific values for river flows should be used. Where river flows are subject to significant seasonal fluctuations in flow, the assessment should consider the low flow situation as the worst case. Information on river flow rates can be obtained from the UK Hydrometric Register [Ref ISBN 0948540842], the Institute of Hydrology (CEH Wallingford) http://www.nwl.ac.uk, or the Northern Ireland Rivers Agency (02890 253 379). Further information is provided in “Ambient Data” (see Reference 12).
3. Where the same substance is released into the same receiving watercourse from different discharge points, the individual process contributions can be combined. This methodology assumes, for simplification purposes, that the contribution of the diluted effluent from discharge points that are in reasonable proximity can be regarded as being diluted within the same volume of water.

   Where discharges are made to different watercourses, the assessment should be carried out separately.

3.5.3 Calculate Process Contribution of Substances Released to (non-Saline) Estuaries

1. **Identify whether the conditions at the point of discharge are freshwater or saline dominated**[note 1]**. If freshwater dominated, follow the procedure below.** If saline dominated, the method for coastal waters should be used in the following section.

2. **If the conditions are freshwater dominated, estimate the process contribution from**:

$$PC_{water} = \frac{(EFR \times RC)}{DR_e} \times 1000$$

where

PC = process contribution (µg/l)

EFR = effluent flow rate from the process (m^3/s) [note 2]

RC = concentration of pollutant in the effluent (mg/l)

DR_e = dispersion rate (estuary) (m^3/s) [note 3]

Note: If you already have detailed dispersion/dilution modelling data available that is valid for the activities in the assessment, then this should be used to derive the appropriate process contribution instead of the method above. **The Operator should identify where this is the case by inputting the modelled data into the software as prompted.**

3. **Provide a summary table of process contributions of releases to water**(note 5)**.** The H1 software tool can be used to calculate and present this information.

Notes

1. Estuaries are considered to extend as far upstream as the tidal limit. The dispersion of substances within the estuary environment is complex and will be highly site-specific. However, for this calculation procedure developed for simple screening purposes, it has been assumed that estuaries are of two types, those dominated by freshwater flows and those, which are predominantly saline. In the case of freshwater estuaries, dispersion is assumed to occur mainly as a result of the effects of current.

   However, for saline dominated estuaries dispersion may occur either through buoyancy (assuming the effluent is freshwater) or current effects. If the conditions for current dominated dispersion are not satisfied, buoyancy dominated dilution applies and the calculation procedure for coastal waters should be used.

   Estuaries in England and Wales are typically current dominated. Information on the nature of estuarine conditions may be obtained from the Regulator at the relevant local office.

2. If releases are discharged to sewer prior to treatment in an estuary sewage treatment works, then the estimated release rate should be modified by the factor calculated in Section 3.5.1 above.

3. Where available, site-specific values for dispersion rate should be used (consult the local Regulator for advice). However, where these data are unknown, an appropriate value from those shown in the Table below may be used [Ref 11]. These values are representative of typical conditions in UK estuaries. This does not take into account the flushing time of the estuary, negatively buoyant plumes and changes to the dispersion during the tidal cycle.

Estuary Type	Nominal Dilution Conditions	Dispersion Rate (estuary), DR_e (m^3/s)
freshwater	low	2.4
	medium	5
	high	10

4. The method derives the 95% ile initial dilution i.e. the reduction in concentration the discharge will receive between the point of release and the open sea surface for 95% of the time.

5. Information on ambient current speed can be obtained from the Regulators at the relevant local office.

6. Where the same substance is released into the same receiving watercourse from different discharge points, the individual process contributions can be combined. This methodology assumes, for simplification purposes, that the contribution of the diluted effluent from discharge points that are in reasonable proximity can be regarded as being diluted within the same volume of water.

3.5.4 Calculate Process Contribution of Substances Released to Coastal Waters

1. **If the releases are to coastal waters or a saline-dominated estuary, estimate the predicted concentration of substances releases from**:

$$\mathrm{PC_{water}} = \frac{\left(\mathrm{EFR}^{2/3} \times \mathrm{RC}\right)}{\mathrm{DR_c}} \times 1000$$

where:

PC = process contribution (µg/l)

EFR = effluent flow rate (m^3/s) $^{(note\ 2)}$

RC = concentration of pollutant in the effluent (µg/l)

DR_c = dispersion rate (coastal waters) ($m^2/s^{2/3}$) $^{(note\ 3).}$

Note: If you already have detailed dispersion/dilution modelling data available that is valid for the activities in the assessment, then this should be used to derive the appropriate and process contribution instead of the method above. **The Operator should identify where this is the case by inputting the modelled data into the software as prompted.**

2. **Provide a summary table of process contribution of releases to coastal waters**$^{(note\ 4)}$**.** The H1 software tool can be used to calculate and present this information.

Notes

1. In coastal waters dispersion may be dominated by either buoyancy or current effect, the latter being derived mainly from tidal flows. For the purposes of this calculation procedure it has been assumed that dispersion is dominated by buoyancy effects, a situation most likely to occur in bays with limited tidal circulation.

2. Where a release takes place to a coastal sewerage system then the estimated release rate should be modified by the factor calculated in Section 3.5.1.

3. Where available, site-specific values for dispersion rates should be used. However, where these data are unknown, an appropriate dispersion rate for those given in the Table below may be used [Ref 11], depending on whether the discharge is to a saline estuary or coastal waters. Advice may be sought from the Regulator at the relevant local office.

Estuary Type	Nominal Dilution Conditions	Dispersion Rate (coastal waters) , DR_c ($m^2/s^{2/3}$)
Coastal waters	low	2.5
	medium	8.0
	high	25
Saline estuaries	low	2.4
	medium	5
	high	15

These represent the initial dilution, which takes place between the point of discharge at depth (5 - 20m) and the water surface. No allowance has been made for any subsequent dispersion.

4. The method derives the 95% ile initial dilution i.e. the reduction in concentration the discharge will receive between the point of release and the open sea surface for 95% of the time.

5. Where the same substance is released into the same receiving watercourse from different discharge points, the individual process contributions should be combined. This methodology assumes, for simplification purposes, that the contribution of the diluted effluent from discharge points that are in reasonable proximity can be regarded as being diluted within the same volume of water.

3.5.5 Screen out Insignificant Releases to Water

1. **Identify the emissions that warrant further investigation of their impacts, by screening out those which are emitted in such small quantities that they are unlikely to cause a significant impact on the receiving water.** This should be done using the method below:
   - Compare the process contribution (PC) of each substance emitted against the relevant environmental benchmark for the substance. Standards and benchmarks are provided in Tables D5 and D6 of Appendix D.(note 1)
   - Identify which releases can be screened by applying the criterion below:

     an emission may be screened out where PC < 1% of the environmental benchmark.(note 2)

     This should be carried out for long term and short-term emissions, where relevant, ensuring that the same statistical basis for mass concentration as the environmental benchmarks is used.(note 3)
2. **Present the information for each option according to the format provided in the H1 software tool.**

Notes

1. The most appropriate environmental benchmark should be selected for each substance. The environmental benchmarks available for releases to water are based on a variety of sources. In selecting the appropriate benchmark or standard from Appendix D, the Operator should consider first the type of receiving water, i.e. whether it is inland, estuarine or coastal.

   EALs for inland water are provided for designated fisheries and more generally for aquatic life. Environmental criteria listed under aquatic life refer to salmonid and cyprinid use. Where the receiving water is a designated fishery under the terms of the EC Fisheries Directive then the criteria listed under "designated fisheries" in Table D6 of Appendix D should be applied. Where more than one requirement might be applied to a particular stretch of water, the most stringent should be applied.

   See Appendix D6 for information on the derivation of EALs. Where EALs are not available for substances, the Operator should discuss this requirement with the local Regulator who, if necessary, can obtain appropriate advice.
2. A criterion of 1% is suggested for screening of releases to water. Note that the screening test does not take the existing environmental quality into account, which can be the dominant contribution for long-term releases rather than the long-term process contribution itself. Nonetheless, a criterion of 1% is two orders of magnitude below the maximum acceptable concentration for the protection of the environment, building in a substantial margin of safety. Even if the existing ambient quality meant that an EQS or other benchmark was already at risk due to releases from other sources, a contribution from the process of less than 1% (which is in itself likely to be an overestimate) is only a small proportion of the total. It should also be noted that the setting of this criterion is to a certain extent pragmatic, taking into account the accuracy of the estimated process contributions and an analysis of the level at which emissions do not tend to influence BAT decisions. To date there is insufficient information for releases to water to justify selecting a less stringent screening criterion. However, ongoing work being conducted by the Regulators may provide evidence to justify revision of this criterion in future.
3. For some substances EALs are available as annual average concentrations and 95 percentile or maximum allowable concentrations (MAC). Annual average criteria should be used for long term releases. Where appropriate information on the flow regime and ambient pollutant concentrations is available to judge whether short term releases are relevant, then the 95 percentile and MAC criteria should be used to assess the short-term impact of these releases. Note also that some EALs are specific to water hardness.

3.5.6 Identify whether Detailed Modelling of Emissions is Needed

The Operator should determine whether detailed dilution modelling should be undertaken of any of the emissions not screened as insignificant, in order to obtain more accurate estimates of process contributions than those obtained through using simplified calculation methods in Section 3.5.1. This judgement should be based on a consideration of the potential risk of breaching an environmental benchmark or the potential risk to a particularly sensitive local receptor. Therefore information on existing background water quality and other local habitats needs to be taken into account. The guidelines below should be used to assist in the decision-making process.(note 1)

1. Obtain information on the long-term background concentrations in receiving water(note 2) of the releases not screened out in step 3.5.5. Then calculate the total predicted environmental concentration (PEC) of that substance by summing the background concentration and the process contribution.

   $$PEC_{water} = PC_{water} + \text{background concentration}_{water} \quad \text{(note 3)}$$

   This should be done for and long-term and short-term (where relevant) releases. (note 4) Summarise the information according to the format provided in the electronic template.

2. **Identify whether any emissions require detailed modelling, taking the following guidelines into account:**
   - if the long term PEC is above 70% of the relevant environmental benchmark; (note 5)
   - where relevant, if the short term PC is more than 20% of the relevant short-term benchmark. (note 5)
   - if there is strong seasonal variation in flow
   - if there are local receptors or habitats which are sensitive to any of the significant emissions.(note 6)

3. **Describe the methods used to carry out further dilution modelling (note 7) for those releases identified above, and revise the process contributions according to the data obtained from detailed modelling.** This information should usually be submitted as a separate report.

Notes

1. The suggested guidelines should not be used in a prescriptive manner, but to guide the Operator in reaching a reasoned judgement of the need to conduct detailed modelling. All of the factors described in notes 4, 5 and 6 below should be taken into consideration in combination in reaching this decision.

2. Background, or ambient, concentrations in rivers should be measured upstream of the point of effluent discharge. For coastal and estuarine waters, further guidance on appropriate background data may be obtained from the Regulator’s local or regional office.

   Information on the existing background concentrations of releases may be obtained from various sources, including:
   - SEPA and Environment Agency area and regional offices and Northern Ireland Environment and Heritage Service (02890 254 754).
   - Institute of Hydrology.

   Further information can be found in the document “Ambient Data” (see Reference 12). In addition, some default values are also provided in Appendix I of this document.

3. Ensure that the same statistical basis has been used for the calculation of values for PC as for information on background concentrations. For simplification purposes, it can be assumed that dilution of the effluent occurs into the same volume of water as that in which the ambient concentration is measured. In this case, the PC can be added directly to the background concentration. In exceptional cases, where the effluent forms more than a small (say 5%) of the total river flow, the PEC should take into account the change in volume.

4. It can be assumed for simplification purposes that short term releases from the process are unlikely to coincide with short-term fluctuations in ambient concentrations, and therefore that the long-term ambient concentration should be used.

5. It is likely that these guidelines are precautionary, and therefore they may be revised in future in the light of further information.

6. The Operator should also consider whether the presence of a nearby sensitive receptor or protected habitat such as shellfish beds, fisheries and abstractions for agricultural purposes, justifies a need for detailed modelling of the effluent to be carried out.

7. It is up to the Operator to select modelling techniques appropriate to the characteristics of the releases. The Operator should consult their local Regulator who, if required, may advise on modelling requirements or provide further information.

3.5.7 Assess Acceptability against Local Environmental Requirements

1. **Check whether the emissions of substances from the proposed options are acceptable in relation to the existing quality of receiving environmental media and any statutory requirements.** This should be done by comparison of the long-term and short-term Predicted Environmental Concentration of substances released to water with the corresponding long-term and short-term EAL or EQS for that substance. In addition, the temperature and the pH of the effluent should be compared against the benchmarks in Appendix D. Summarise the information according to the format provided in the H1 electronic software tool.
2. Identify any releases where the EAL or EQS is already exceeded, or where the contribution from the installation will result in the EAL or EQS being exceeded.

   Such options are unlikely to be acceptable and should normally be ruled out of further consideration in this appraisal.(note 2)

   The Operator should supply a qualitative response to this section, as indicated in the software tool.

Notes

1. Environmental Quality Standards (EQSs) and Environmental Assessment Levels (EALs) are benchmarks of environmental impact or harm. In assessing the impact of an installation against these benchmarks, consideration of the background contribution from other pollution sources should be taken into account. If a release from an IPPC installation constitutes a major proportion of an EQS or EAL, or makes a major contribution to the breach of an EQS or EAL, then this may not be judged to be acceptable.

   Environmental Quality Standards may be set by the European Community or nationally. In assessing whether the emissions from the activities comply with these standards, reference should be made to the exact conditions that apply to the standards (see Table D5 for water quality standards).
2. The effects of compliance with environmental quality standards should be considered within any assessment of BAT, and also as part of the environmental impact assessment for the installation as a whole. In certain cases, it may be considered that further pollution control techniques, at higher cost, are justified as BAT in order to preserve the quality of the local environment.
3. The Regulations require that the effects of compliance with any environmental quality standards (EQSs) should be considered within any assessment of BAT. These include Community EQSs and national EQSs. Refer to “IPPC: A Practical Guide” (see Reference 5) for further information.

   If an EU EQS is already exceeded or may be exceeded as a result of a further contribution from an IPPC activity, consideration of further control measures beyond indicative BAT needs to be taken. This should take into account the practicality and reasonableness of further control measures, based on the contribution that the installation makes toward the breach and the likelihood of remedial action elsewhere. Where a new installation would only make a minor contribution to a breach, it will normally be more desirable for Regulators to control other major sources of pollution rather than imposing excessive costs or refusing a Permit. National EQSs do not have the same legal status as EU EQSs, and there is no explicit requirement to impose stricter conditions than BAT in order to comply with a national EQS. However, national EQSs are a benchmark for harm and any significant contribution to a breach may also be unacceptable.

   Community and National EQSs exist only for a limited number of substances emitted to air and water. However, the Regulator has derived provisional benchmarks for substances released to each environmental medium from a variety of published UK and international sources, known as “Environmental Assessment Levels” (EALs). Although these do not carry any statutory basis, they are, again, a benchmark for harm against which any exceedance should be viewed as unacceptable.

3.5.8 Summarise the Impact of Emissions to Water

1. **For each option, list all substances emitted to water, that have not been screened as insignificant.** This should be done for long-term emissions only.(note 1) Where there are no emissions that warrant detailed investigation for any or all of the options, as they have been screened from the assessment in Section 3.3.2, the Operator should state that this is the case.
2. Normalise the process contribution of each substance (as calculated in Sections 3.5.2 - 4) against the appropriate environmental benchmark (EQS or EAL) (note2) for that substance, according to the formula below. The resulting figure is known as the environmental quotient (EQ).

$$\mathbf{EQ_{(Substance)}} = \frac{\underline{\textbf{Process Contribution } (\mathbf{PC_{substance}})}}{\mathbf{EAL_{substance}}}$$

3. **Sum the environmental quotients to provide total impact of emissions to water for each option**. If the environmental benchmarks used for normalisation are derived on the same basis then the environmental quotients (EQ) can be added to obtain a cumulative total impact. i.e.

$$\mathbf{EQ_{water} = EQ_{substance\ 1} + EQ_{substance\ 2} + \ldots\ldots\ldots}$$

The H1 software tool may be used to calculate and present this information as histograms.

Notes

1. Short-term effects are determined primarily to assess whether options are acceptable. It is more appropriate to use long-term effects to comparisons relative environmental impact between options. The weight that short term effects should play in the final ranking of options and selection of BAT should be commensurate with the importance of the effects. The operator should justify this as part of the decision-making process in module 4.
2. The direct environmental effect of a substance released to a particular environmental medium is assessed as the ratio of the process contribution to the EAL for that substance in that medium. This quantity is denoted the environmental quotient (EQ) for that substance in that medium.

   Clearly these indicators do not provide a completely scientifically accurate assessment of the effects of the releases on the environment. They are based, for example, on assumptions that effects are linearly proportional to the concentration of a substance in the environmental medium into which it is released; that the EALs correspond to identical levels of effect for all substances and all media; and that there are no synergistic or antagonistic effects between substances. However, for the purposes of comparing control options at a particular location, where the nature of the receiving environment will be effectively the same for all options, the EQs provide simple, robust indicators of relative impacts which are sufficient for the majority of applications.

3.6 Quantify Impacts of Noise

AIM

This section need only be completed for **OPTIONS APPRAISAL** only, in order to:

- establish whether the noise emissions are acceptable, and
- where a number of options are acceptable, to rank them according to the risk of noise emissions.

When conducting an **ENVIRONMENTAL ASSESSMENT** of the installation as a whole, the assessment of noise will be undertaken in any case as part of the application procedure, using the Regulators' IPPC H3 Horizontal Guidance Note for Noise (Reference 8), and according to the guidance set out in section 2.9 of IPPC Sector Guidance Notes. Such an assessment should be submitted separately from the H1 assessment.

In many cases, noise impacts may not be of a sufficient level to warrant detailed investigation, either because they do not occur or because they can be controlled to an acceptable level. However, Operators should confirm whether this is the case by following the guidance below.

FOR OPTIONS APPRAISAL ONLY

3.6.1 Screen out Insignificant Noise Impacts using Qualitative Methods

1. With reference to the noise sources identified in module 2, screen out any options or potential noise sources for which noise impacts are insignificant using the following guidelines.
    - Existing installations which are inherently quiet and do not pose any risk for noise or vibration can be screened out.
    - Existing installations which do have the potential for noise but which have controlled it adequately and for which the BAT requirements of Section 2.9 of the Sector Guidance Note are met (in particular that noise from the installation does not give rise to justifiable cause for annoyance) can be screened out.
    - Existing installations that have potential noise sources but where it is not a problem due to remote location, may be screened out.
    - Where the choice of options will not affect the level of noise (i.e. will be less than the existing background levels), these can be screened out.
    - It may also be possible to argue, qualitatively, that new plant is inherently quiet and does not pose any risk for noise or vibration above the existing background. However, this has to be done carefully and if there is any doubt the noise levels should be identified and the calculation steps below carried out.

    The above information can be presented in the software tool as indicated.
2. **For any options and noise sources not screened out here, continue below.**

3.6.2 Calculate Predicted Levels of Noise using Simple Methods

1. Identify the nearest sensitive receptor(s) and, where appropriate, the measured or calculated noise levels there.(note 1)

    This applies to any activities not screened in Section 3.6.1 where options will affect the level of noise. The Operator should identify the main noise sources for each option and their noise emissions or sound pressure levels (note that this is required as part of the requirements of Section 2.9 of the Application in any case) and should then:
2. **Consider whether it is appropriate to sum the sources or whether, for a particular noise sensitive location, the sources should be assessed separately.** This will depend on:
    - the location of the nearest noise sensitive locations around the site
    - the size of the site
    - the location of the sources on the site
    - whether a particular noise source dominates
    - the degree to which sources are distinctively different in nature.

    For the purposes of this simplified prediction exercise, all noise levels are to be considered in terms of dB(A)L_{aeq} levels.

Cont......

3. **Where it is appropriate, sum the sources using the following approximation**, referring to Part 2 of the IPPC H3 Noise Guidance for further guidance (see Reference 8).

Difference between the two sound levels dB(A)	Addition to the higher level dB(A)
0	3
1	3
2	2
3	2
4	1
5	1
6	1
7	1
8	1
9	1
10 or more	0

4. **Estimate the noise at the nearest noise sensitive location, based on distance of this from the nearest source at the installation, according to the following approximations:** (note 1)

For each doubling of distance from a point source	reduce by 6 dB
For each doubling of distance from a line source (if receptor is within 3 times its length - else consider to be a point source)	reduce by 3 dB

5. **Record any complications, which might invalidate the above approximations and assess whether modelling may be required** (note 2). Note that if peak noise levels could be an issue from intermittent short-duration sources (valves etc) then a detailed assessment of resultant maximum levels should be performed.

   If low frequency noise or vibration is deemed to be an issue beyond the installation boundary at sensitive receptors then, due to the complexity of the subject, specialist advice should be sought.

Notes

1. Note that these approximations are based on formulae describing geometric divergence, as described in more detail in H3 (see Reference 8), together with the definitions of point and line sources.
   - A barrier, or other feature between the source and the receiver will give an approximate attenuation of 5dB(A) when the top of the plant is just visible to the receiver over the barrier and 10 dB(A) when the barrier or feature completely hides the source from the receiver.
   - Note that the “rating level” is calculated according to BS4142. This implies that if the noise under consideration has a specific tonal or impulsive characteristic, then a penalty of +5dB has to be added to the calculated value.
2. Modelling may be necessary for either new or existing installations where:
   - the noise situation is complex due to the number of sources on the installation or in the vicinity especially where monitoring is not feasible
   - where the Operator wishes to justify less stringent levels than either:
     - the Indicative BAT Requirements or
     - some more stringent levels which are, in the view of the Regulator required to satisfy local circumstances (e.g. to avoid “creeping background”)
   - other issues were identified above which invalidate the approximations made.

3.6.3 Compare Predicted Levels of Noise with Actual Background

1. **Establish the background noise levels at the noise sensitive locations.** (note 1) The background noise levels should be measured according to the nature and pattern of the source emissions, incuding daytime and night-time measurements as appropriate.
2. **Screen out as insignificant any noise sources that are less than (background – 5dB (A)).**

Notes

1. Refer to guidance note H3 for guidance on measurement method. In some circumstances the background levels might be available from the Local Authority, in others it will be necessary for the Operator to carry out a noise survey.

   Some everyday sources and noise levels are provided in the table below (taken from horizontal guidance note H3 Noise). This information is illustrative only, in order to put noise levels calculated above in the context of other everyday situations.

Situation/Noise Source	Sound Pressure Level in dBA	Sound Pressure in mPa	Average subjective description
30 m from a military jet aircraft take off	140	200,000,000	Painful, intolerable
Pop concert	105	3,500,000	
Night club	100	2,000,000	
Pop concert at mixer desk	98	1,600,000	
Passing heavy goods vehicle at 7m	90	630,000	Very noisy
Ringing alarm clock at 1m	80	200,000	
Domestic vacuum cleaner at 3m	70	63,000	Noisy
Business office	60	20,000	
Normal conversation at 1m	55	11,000	
The reading room of the British Museum	35	1,100	
Bedroom in a quiet area with the windows shut	30	630	Very quiet
Remote country location without any identifiable sound	20	200	
Theoretical threshold of hearing	0	20	Uncanny silence

3.6.4 Check Acceptability of Noise Impacts

1. **Where the noise levels are not screened as insignificant, assess the acceptability of the Rating Levels** against:
   - the numerical value of the Background Sound Level ($L_{A90,T}$) (Background related Indicative BAT Requirement)
   - the free field level of 50dB L_{Aeq} by day or 45 by night (Absolute Indicative BAT Requirement)
   - any existing planning or other levels

   Refer to sections 2.6.4 and 2.5 of IPPC H3 Noise guidance for further information.

2. **Provide justifications where the noise levels exceed the BAT benchmarks**. Where this cannot be done it will be necessary to re visit the techniques or, where this is not possible, reject the option.

   Note that, as with any approximation process, there will be an associated margin of error, so careful consideration needs to be given when predicted levels are close to breaching background benchmark values.

3.6.5 Summarise Noise Impacts

For acceptable options rank the options simply according to their noise levels at each sensitive location.

3.7 Quantify the Risk of Impacts from the Consequences of Accidents

Aim

The aim of this section is to estimate the risks associated with the consequences of potential accidents and to compare this inherent risk between options.

This section need only be completed for **OPTIONS APPRAISAL** as it is assumed that for the installation as a whole, and for any of the options considered, that operators will apply the necessary accident prevention techniques (including those requirements for COMAH, where relevant).

The assessment of overall risk of impacts from the consequences of accidents for the installation as a whole should follow the procedure described in Section 2.8 of Sector Guidance Notes. That note provides general guidance on the assessment procedure to demonstrate satisfactory measures are in place.

It is a requirement of IPPC that an Operator ensure that measures are in place throughout all of the Permitted activities to control environmental impacts associated with accidental releases. Therefore, the aim of this module is not to determine what is BAT for the application of preventative techniques, but to make an overall comparison of the inherent risk of a process or option.

FOR OPTIONS APPRAISAL ONLY

3.7.1 Identify the Hazards Posed by Each Option and their Likelihood

1. **Identify the hazards which exist and which could give rise to an incident with environmental consequences.**(note 1) These should be based on hazards associated with the use or processing of materials (including substances arising from the use and processing of materials), as well as the storage and movement of materials within the boundary of the installation. These can be grouped into the following general activities:
   - Transportation (e.g. by tanker) within the installation boundary
   - Residence in storage
   - Process operations
   - Emissions (including wastes) arising from the process
   - General security issues

   This information should be tabulated according to the example provided in the H1 software tool.

2. **Identify the possible incidents associated with each of the identified hazards.**(note 2) The Operator should consider the following incident categories, proposed as a general guide for the scope of assessment.

   For each option, list all foreseeable but unplanned incidents that could occur within the lifetime of the option using the general categories below. Where a category is not relevant, the Operator should state the reason why this is the case.

   Incident Categories

   - **Transport management and control** (e.g. is there a lot of site traffic, which increases the risk of an incident?)
   - **Control of material transfer including waste handling and disposal** (eg unsupervised delivery resulting in increased incident risks such as uncontrolled or out of compliance releases, contact between incompatible materials etc.)
   - **Failure of containment** (e.g. probability of leakage through tank/pipe/valve corrosion due to reduced inspection/maintenance programme, vandalism etc.)
   - **Foreseeable but unplanned incidents in process operations** (such as control or abatement failure, process perturbation/runaway reaction, emergency flaring, pressure relief, maintenance errors etc.)

   In certain cases the following categories should be included if relevant:

   - **Vandalism** (how secure is the site?)
   - **Emergency response** (e.g. firewater containment)
   - **Other site-specific incident types**

Cont.........

3. **For each of the incidents identified, assign a likelihood category using the table below.** In assessing the potential incidents, only those that would occur within the lifetime of the technique would usually be relevant for consideration.

Likelihood Categories

	Category	Range
1	Extremely unlikely	Incident occurs less than once in a million years
2	Very unlikely	Incident occurs between once per million and once every 10,000 years
3	Unlikely	Incident occurs between once per 10,000 years and once every 100 years
4	Somewhat unlikely	Incident occurs between once per hundred years and once every 10 years
5	fairly probable	Incident occurs between once per 10 years and once per year
6	probable	Incident occurs at least once per year

4. **Summarise the information for each option according to the format provided in the electronic software tool.**

Notes

1. Note that within the techniques selected for options appraisal, general measures for the prevention and minimisation of hazards would be expected to be in place, as described in Section 2.8 of IPPC Sector Guidance.

It may also be the case that the main objective of the appraisal is to assess the relative benefits of alternative options to reduce the risk of impacts from the consequences of accidents, where the Operator is considering candidate methods such as:

- elimination of hazardous process stages or operating under less hazardous conditions (e.g. lower temperature and pressure)
- use of less hazardous materials
- reducing the inventory of hazardous materials
- improving plant layout to reduce consequences or
- using preventative techniques rather than end-of-pipe abatement.

It is not necessary to make a detailed assessment for the purposes of options appraisal (the detailed assessment will be required for the installation as a whole in any case as part of Section 2.8 of the application requirements). The incident categories are generally based on foreseeable but unplanned accidents.

This assessment process is to some degree subjective, so in order to obtain a reasonable estimation of possible frequencies of events, it is recommended that the assessment is a consensus of several opinions.

3.7.2 Assess the Possible Consequences of All Incidents

1. **For each option, briefly describe the main environmental consequences associated with each incident identified in the section above.** This should include the following:
   - which materials can be released
   - the maximum quantities of each material released
   - the pathway and receptor of the release
   - the consequences of the material reaching a receptor (e.g. odour nuisance causing complaint, water pollution causing damage to aquatic species, release to air resulting in hospital treatment).

2. **Using the table below, estimate the severity of the likely consequences and assign the incident within the appropriate category.**

	Category	**Definition**
1	minor	• nuisance on site only (no off-site effects) • no outside complaint
2	noticeable	• noticeable nuisance off-site e.g. discernible odours • minor breach of Permitted emission limits, but no environmental harm • one or two complaints from the public
3	significant	• severe and sustained nuisance, e.g. strong offensive odours or noise disturbance • major breach of Permitted emissions limits with possibility of prosecution • numerous public complaints
4	severe	• hospital treatment required • public warning and off-site emergency plan invoked • hazardous substance releases into water course with ½ mile effect
5	major	• evacuation of local populace • temporary disabling and hospitalisation • serious toxic effect on beneficial or protected species • widespread but not persistent damage to land • significant fish kill over 5 mile range
6	catastrophic	• major airborne release with serious offsite effects • site shutdown • serious contamination of groundwater or watercourse with extensive loss of aquatic life

3. **Summarise the information on severity according to the format provided in the electronic software tool.**

3.7.3 Assess the Risk Resulting from Each Incident

1. **For each option, assess the overall risk of each incident by multiplying the severity of consequence by its likelihood**. This table below illustrates the scores obtained by this method.

Likelihood	**Severity of Consequence**					
	minor	**noticeable**	**significant**	**severe**	**major**	**catastrophic**
extremely unlikely	1	2	3	4	5	6
very unlikely	2	4	6	8	10	12
unlikely	3	6	9	12	15	18
somewhat unlikely	4	8	12	16	20	24
fairly probable	5	10	15	20	25	30
probable	6	12	18	24	30	36

2. For each option, identify which incidents fall into the following score categories:

magnitude of risk	**score**
acceptable	6 or less
acceptable if reduced as reasonably practical	8 to 12
unacceptable	15 or more

3. **If none of the options result in incidents with an individual risk rating of more than 6, no further assessment is necessary.** The Operator should record that this is the case.

4. **If any of the options result in incidents with an individual risk rating of 15 or more, the option should be ruled out as unacceptable.**

   This information can be presented in the software tool.

3.7.4 Summarise the Overall Risks for Each Option

1. For options not ruled out in Section 3.7.3, assess the overall risk by summing the scores of individual incidents to obtain a total risk score for the option. The overall risk score should be presented according to the format in the electronic software tool.(note 1)

Notes

1. Provided that there are no unacceptable risks, there is no upper limit at which a cumulative risk score would disqualify an option, as there is no limit to the number of hazards that can be addressed in the assessment method. The more complex that an option is, the more there may be an overall possibility for something to go wrong.

3.8 Quantify Visual Impacts

AIM

The aim of this section is to identify whether there are any relevant visual impacts associated with the activities that are of a scale that may influence the selection of BAT. Visual impacts that may be relevant are only those associated with the operation of the process, such as plumes from stacks or effluent discharges, and not the visual impact of buildings themselves.(note 1)

Note that for many PPC activities, this consideration will not be an issue and visual impacts may be screened from further assessment by providing a simple qualitative response as indicated in the guidelines below.

3.8.1 Screen out Activities or Options that do not result in a Visible Plume.

1. **Identify whether the process could generate a visible plume.**(note 2) This should take the following into account:
   - the nature of the process emissions (temperature, humidity etc.); noting that there should be no visible emissions other than condensed water vapour
   - a review of any visible impact complaints for existing or similar processes, or observation records made by the Operator
   - a review of any other complaint records that by their pattern suggests conditions or activities under which these plumes have been caused

   If the activities do not result in any visible plumes then no further assessment is necessary.

2. **List each source of visible plume and determine whether the plume extends beyond the installation boundary.** This can be checked by making observations at regular intervals (e.g 3 – 4 times a day) over a suitable time period (e.g. one month, depending on variability of the process over time). Ensure that the observations are made during either unfavourable meteorological conditions or at least under a variety of meteorological conditions; eg. during the summer months visible plumes will be minimal compared with winter months due to ambient temperatures and humidity.

   If the plume does not extend beyond the boundary for more than 5% of the time, then no further assessment of that source is necessary. (note 3)

3. **If any of visible plumes generated extends beyond the site boundary, the assessment should be continued.**

Notes

1. This assessment considers only the visible impacts of a plume, ie obscuration. Measures to prevent and minimise other potential environmental consequences of plumes, such as grounding and odour, are covered by the requirements for assessing the impacts of emissions to air and odour in the relevant sections of H1. In addition, determination of appropriate stack height in relation to dispersion requirements and consideration of alternative options for the control and dispersion of releases is covered elsewhere in Sector Guidance Notes.

   Although visible plumes to all media are of concern, in practice it is likely to be plumes to air that are the greatest issue. A visible plume to surface water would be unlikely to be allowed, whereas with many processes a degree of atmospheric plume visibility from condensation of water vapour is unavoidable. No other visible emissions should be made. However, note that certain plumes can become visible under certain lighting conditions. If this is the case, then the operator should assess these in a similar way to plumes generated by the condensation of water vapour.

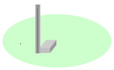
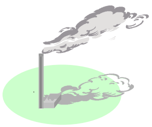
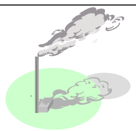
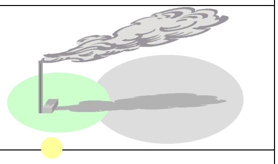
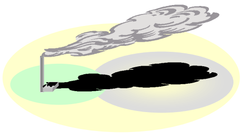
2. Visible plumes arise from gas flows to air which are above ambient temperature and which, as the gases are cooled to ambient temperature, result in the condensation of water vapour. This results in a white plume. Such plumes often arise from combustion processes. The extent of a plume is dependent on:
   - the volumetric flow rate of gases from the source
   - the amount of water vapour in the cooled gases
   - the relative humidity of the atmosphere
   - the dispersion of the plume in the atmosphere

   Guidance on measures to reduce plume visibility is provided in IPPC Sector Guidance Notes.

3. The Operator may also wish to make a case for screening out insignificant impacts if the plume does extend beyond the boundary but where there are no sensitive receptors due to the remoteness of the location.

3.8.2 Quantify the Potential Impact from Visible Plumes

1. Determine the method used to quantify the potential impacts, by considering the following:
    - if the source temperature and moisture can be determined or predicted accurately, use a quantitative method (e.g. dispersion model) to investigate plume visibility, and **proceed to step 2;**
    - if the source temperature and moisture content cannot be determined, use a qualitative risk assessment and **proceed to step 3.**
2. **Provide a quantitative assessment of plume visibility by following the procedure below.**
    - Estimate the frequency and dimensions of the plume using an appropriate dispersion model.
    - Determine the average distance from the source being assessed to the installation boundary (e.g. from direct measurement of reference to site plans).
    - Use the model forecasts to estimate the amount of time the length of the plume may exceed the average distance to the installation boundary.
    - For each source of visible plume, summarise the assessment by providing information on the number of plumes that exceed the average distance to the installation boundary during daylight hours and assign a score from the table below.
3. **Provide a qualitative assessment of plume visibility by following the procedure below.**
    - Where available, review visible impact records and summarise findings.
    - Conduct a programme of observations and state the number of observations of visible plumes that extend beyond the installation boundary.
    - Use the table below to assign a score according to the magnitude of impact.

impact	quantitative description	qualitative diagram
zero	• no visible impacts resulting from operation of process	
insignificant	• regular small impact from operation of process • plume length exceeds boundary <5% of daylight hours per year • no local sensitive receptors	
low	• regular small impact from operation of process • plume length exceeds boundary <5% of daylight hours per year • sensitive local receptors	
medium	• regular large impact from operation of process • plume length exceeds boundary >5% of daylight hours per year • sensitive local receptors	
high	• continuous large impact from operation of process • plume length exceeds boundary >25% of daylight hours per year with obscuration • local sensitive receptors	

This information can be input into the software tool as indicated.

Note that the pictures indicate plume appearance when there is a wind; a record of observations during low wind speeds would be very informative particularly on cold winter days in calm conditions.

3.8.3 Determine Whether the Impact is Acceptable

1. **Use the visible plume score to determine the acceptability the impact from the plume.** Conditions that result in medium or lower impacts can be considered acceptable. Those activities that result in visible plumes that lie within the high impact category may need to consider further control measures to reduce the impact.

3.9 Quantify Impacts of Odour

AIM:

This section need only be completed for **OPTIONS APPRAISAL**, in order to:

- rank the options according to the risk of odour emissions, and
- establish whether the odour emissions are acceptable.

ENVIRONMENTAL ASSESSMENT of the impacts of odour from the installation as a whole should be undertaken separately as part of the application procedure, using the IPPC H4 Horizontal Guidance Note for Odour (see Reference 9) and according to the requirements set out in section 2.2.6 of IPPC Sector Guidance Notes. Such an assessment should be submitted separately from the H1 assessment.

Odour is similar to noise in that both are “annoyance” issues, having elements of subjectivity associated with them. It is difficult to attribute any physical health effects which might underpin emission or exposure limits. Instead, impacts are assessed upon what is “acceptable” to those exposed. The following guidelines are based on this principle.

OPTIONS APPRAISAL ONLY

3.9.1 Screen out Insignificant Odour Impacts using Qualitative Methods:

2. **Identify those sources and/or options that are low risk and that can be screened from the need for further assessment.** Odorous compounds and their potential sources will be listed already in the emissions inventory in module 2. **The following guidelines can be used for screening:**
    - existing activities which are inherently odour free and where the choice of techniques does not pose any additional risk for odour(note 1)
    - options where the odour is contained, the risk of containment failure is low and for which the BAT requirements of Section 2.3 of Sector Guidance are met(note 2)
    - existing activities which have the potential for odour but where it is not a problem due to its remote location(note 3)
    - where the choice of options will not affect the level of odour.

   A qualitative response should be provided to confirm the reason why any of the potential odour sources have been screened out, as prompted in the software tool.
2. **For any options not screened out here, continue with the following steps.**

Notes

1. It may also be possible to argue, qualitatively, that new plant is inherently odour free and does not pose any risk. However, this has to be done carefully and if there is any doubt, the potential odour sources should be identified and the appropriate assessment carried out.
2. The Operator should provide a description of the situation, which provides justification for screening such options, and should demonstrate that the risk of containment failure is low.
3. The remote location should relate to the risk of causing odour-related annoyance at sensitive receptors and should take into account the possibility for future development of the land in close proximity to the installation (for example, for housing development).

3.9.2 Categorise the Type of Odour Risk

1. **Where there is a potential odour source that has not been screened out, use the simple risk assessment chart below to assign a category, and risk within that category, to each source within each option.** **(note 1)** The information can be input into the H1 software tool as indicated.

category	risk	characteristic of source and emissions
1	low or medium	A **low** risk would be a remote location with no record of justified odour complaints. The risk could be **medium** if odour emissions are of sufficient mass that complaints would be received if receptors were closer, or if new land development encroaches on the installation boundary.(note 2)
2	low or medium	Risk will be **low** if measures to contain odour are in place, or it is discharged without need for dispersion, treatment leaves no residual odour and discharge is at high or low level. Odour stream may be fed into and consumed within a further process. Risk may be **medium** if the above apply but there is risk of failure of control method.
3	low, medium or high	Measures to contain odour are in place or it is discharged with dispersion. Release is usually at high level, e.g. stack or roof vent. Treatment leaves a residual odour, or there may be no treatment. Risk may be **medium** in these cases. There is a reliance on adequate dispersion to prevent annoyance at receptors. Risk may be **high** if plume conditions are not well-characterised.
4	low, medium or high	Odour-producing activities take place in the open. Cannot be contained by virtue of the type of activity (e.g. effluent treatment plant which cannot be covered, landfilling of putrescible wastes, lagoons etc). Measures to contain rely on good management techniques and adherence to best practice to minimise odour generation.

2. **Any sources or options that have a low risk in categories 1 and 2 can be screened from further assessment.** All other sources should continue to the next stage of assessment.

Notes:

1. Odour emissions can be difficult to measure and their impacts are often complex to assess. This categorisation step is carried out in order to determine the most appropriate method of assessment. Different assessment methods are proposed depending on the type of source/emission and whether it is possible to meaningfully measure or predict the emissions. For information see IPPC H4 Horizontal Guidance Note on Odour (see Reference 9).
2. The Operator will still be required to work towards BAT in these situations, although there may be scope to adjust the timescales to achieve this.

3.9.3 Estimate Odour Impacts

1. **For emissions that lie in categories 1 – 3 above, estimate the impacts using dispersion modelling.** (note 2) This should include calculation, estimation or measurement of the concentration of substances at the odour sensitive receptors. The H4 guidance note provides further guidance on methods for conducting dispersion modelling.

   This information should usually be provided as a separate report to supplement the information input into the H1 software tool.

2. **For emissions that lie in category 4 of the above table, use the following guidelines to assess the odour impacts:**

   - If the emissions can be measured or estimated reliably then modelling should be considered as in (1) above.
   - If the emissions cannot be measured reliably, then other types of assessment are necessary. Consider the following and consult IPPC H4 guidance for further information:

cont'd

- for existing plant, review the complaint history (possibly compared with logged activities at the time the odour that provoked complaint occurred)
- conduct community based surveys or “sniff-testing” at the boundary fence or location of nearest sensitive receptors
- for new plant, estimate the impact by comparison with a similar undertaking.

This information should usually be provided as a separate report to supplement the information input into the H1 software tool.

Notes

1. Where emissions can be measured, quantify the concentration of the substance at the nearest sensitive receptor, or the mixture of odorants or a single surrogate compound which is representative of the total mixture. The justification for selection of a surrogate must be given.

   Where emissions cannot be measured directly it may be possible to predict emissions by using emission factors, mass balance data or a comparison with similar processes (see H4 Part 2 for a description of the options available).

   Worst case scenarios should be considered in terms of their impact on receptors, as well as “normal” operations.
2. The preferred parameters for dispersion modelling are described in Appendix 4 of H4 Part 1. The Operator may use other parameters but should justify their use.

3.9.4 Check Acceptability and Summarise the Impacts of Odour.

1. Check whether the predicted exposure levels are acceptable to the local receptors. (note 1) Reject any options that result in unacceptable levels.
   - For category 1- 3 sources: compare the odour levels at the nearest sensitive receptor to any available benchmarks.
   - For category 4 sources: identify options where the results of complaint history or surveys indicate that the risk could be unacceptable.
2. **Assess the relative odour impact for each option.** This may be expressed in whatever way is appropriate. (note 2) For example, concentration at the sensitive receptor, or in relation to a detection threshold, or as a qualitative low, medium, high ranking.

All relevant information and appropriate justification should be presented as a separate report to supplement the responses made in the H1 software tool.

Notes

1. Guidance on acceptability is provided in H4 IPPC Horizontal Guidance Note on Odour (see Reference 9). Acceptability can be expressed in the form of exposure criteria (ground level concentrations as a percentile of hourly averages) at sensitive receptors, or other published guideline values. H4 also contains information on odour thresholds.
2. Where a reliable estimate of emissions is not available, a qualitative judgement on the likely impact will have to be made. Use of BAT should minimise or prevent odour and clear evidence that the appropriate procedures are in place for odour control should be provided. For comparative purposes the following impacts should be considered:
   - Is the odour detectable at sensitive receptors?
   - Is it of high, medium or low offensiveness?
   - Is it likely to be strong, distinct or faint?
   - What is the likely exposure occurrence – Frequent, occasional, infrequent?
   - What is the likely duration at each occurrence – seconds, minutes, hours at a time?

   See H4 IPPC Horizontal Guidance Note on Odour further guidance.

3.10 Quantify Photochemical Ozone Creation Potential

Aim

The aim of this section is to identify all substances released to air that have the potential, by indirect photochemical reaction, to create atmospheric (low level) ozone, and to quantify the magnitude of this potential.

The method, described below, is based on a simple assessment of the relative reactivity of different substances. There is no screening step so all emissions with the potential to create ozone should be addressed.

3.10.1 Photochemical Ozone Creation Potential (POCP) (note 1)

1. **For each option, identify which emissions to air (as listed in the inventory in module 2) have potential for photochemical ozone creation.** Substances having potential for photochemical ozone creation are identified in Appendix G. Where none of the options result in emissions of substances with potential for photochemical ozone creation, the Operator should state that this is the case.
2. **Calculate the individual Photochemical Ozone Creation Potential (POCP) contribution for each substance** by multiplying the annual mass released by the POCP value from Appendix G. Ensure that the same mass basis is used for all substances and options. Sum total POCP for each option
3. **Present the impacts as relative Photochemical Ozone Creation Potential for each option**, according to the format provided in the H1 software tool.

Notes

1. Ozone is a highly reactive pollutant, which may damage human health, vegetation and materials. The production of ozone involves the action of sunlight on volatile organic compounds (VOCs) and oxides of nitrogen (NOx). The availability of NOx downwind of a source controls the spatial extent of the area within which raised ozone concentrations may be generated. Within this area the magnitude and distribution of the pollutant is controlled by the occurrence and characteristics of the available VOCs.

   There is a large variation in the importance of different VOCs in the production of ozone depending on their structure and reactivity. In order to assess the relative effect of different hydrocarbons in the episodic production of ozone and provide a basis for their control the UNECE VOC convention (see Reference 18) has proposed the concept of the Photochemical Ozone Creation Potential (POCP). The POCP is defined as the ratio of the change in photochemical ozone production due to an emission of a particular VOC to the ozone created by the same additional emission of ethylene, i.e.:

$$POCP_i = \frac{Ozone\ increment\ \ for\ i_{th}\ hydrocarbon}{Ozone\ increment\ with\ ethylene} * 100$$

   POCP values are provided in Appendix G, that have been derived for organic compounds and NOx concentrations typical of northwest Europe using a Master Chemical Mechanism.

3.11 Quantify Global Warming Potential

Aim

The aim of this module is to identify which substances released from the activities have the potential to contribute to global warming and to quantify their effect. These types of substances are known as "greenhouse gases".

The method includes an assessment of all direct releases of greenhouse gases from the activities (including process- and energy-related emissions) as well as indirect emissions of greenhouse gases from the primary source of heat or power imported for use in the activities. In this way, the environmental impacts of efficient use of energy are taken into account in the assessment.

The method of assessment is based on a simple calculation of the relative activity of different substances to produce a combined Global Warming Potential score for each option. There is no screening step so all emissions of greenhouse gases should be addressed.

3.11.1 Quantify Global Warming Potential (note 1)

1. **Identify all releases of greenhouse gases that arise from the activities for each option**(note 2), with reference to the list provided in Appendix H. These emissions should have already been quantified as part of the emissions inventory in module 2, and should include:
    - direct emissions produced or associated with the storage, handling and process operations of the activities;
    - direct emissions produced or associated with energy used within the activities that is produced within the installation;
    - indirect emissions associated with heat or power used within the activities that is imported into the installation;
    - any other relevant indirect emissions.(note 3)

   The emissions can be listed according to the format in the electronic software tool. (note 2)
2. Calculate the individual global warming potential for each substance by multiplying the annual mass released by the Global Warming Potential value listed in Appendix H(note 4). Ensure that the same mass basis is used for all substances and options.
3. **Calculate the total global warming potential of each option by summing the individual contributions.** The information should be presented according to the format in the electronic software tool.

Notes

1. Due to the nature of the effects arising from these pollutants, we have no universally acceptable methodology that assesses them by looking at their environmental concentrations. The Agency has therefore developed a separate index which is calculated by establishing the annual mass of each gas released from the process to air and multiplying by an index of the global warming potential (GWP) of that gas. The GWP is defined as the cumulative radiative forcing between the present and a future time "horizon" caused by a unit release relative to some reference gas, in this case CO_2 (see Reference 19). This can be done for all gases released from an option and summed to give the overall Global Warming Potential.
2. The release of "greenhouse" gases, such as carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFCs), and other halocarbons may lead to global warming. The release of these gases is often associated with the use of energy as well as the direct processing of materials. In the case of releases associated with energy, the Operator should include those greenhouse gases that are released as a consequence of the direct conversion of energy at the installation as well as imported energy such as electrical power. This will require the Operator to assess the amount of energy associated with each option, its source and the amount of greenhouse gas released per unit of energy used in the option.

   Emissions for energy-related greenhouse gases should be quantified according to the guidelines given for the emissions inventory in module 2. Standard factors for carbon dioxide emissions are available for certain primary fuels and for converting electricity imported from the public supply back to primary energy.

The Regulators consider that this approach best fulfils the requirement of Schedule 2 (9) of the PPC Regulations to consider the energy efficiency of the process in the determination of BAT, given that the major environmental impacts of energy efficiency are associated with releases to air.

3. This should be strictly limited to situations where there is an obvious need to include indirect emissions that would otherwise distort the validity of the assessment. Such situations may arise when comparing options using raw materials that have been subjected to different levels of pre-treatment before use at the installation. For example, the use of lime instead of limestone as a reagent for the scrubbing of acid gases will result in similar carbon dioxide emissions being released to the atmosphere, but in the case of the option using lime, these have taken place at the point of primary production. It is recommended that Operators seek advice from the Regulator regarding circumstances when the consideration of other indirect emissions may be relevant.

4. Where carbon dioxide emissions result from the use of renewable energy sources (such as biomass or waste) a factor of zero should be assumed for global warming potential. This is to conform with convention to treat such emissions as carbon dioxide neutral.

3.12 Quantify Impacts from Disposal of Waste

Aim

This section need only be completed when conducting options appraisal of techniques, in order to compare the relative risk of impacts between options. An assessment of waste disposal for the installation as a whole is undertaken as part of the requirements of the Sector Guidance or Application Template. **The aim of this module is to assess the impacts relating to the disposal of wastes arising from the activities, by consideration of:**

- **the nature of the waste;**
- **the method of disposal or treatment selected;**
- **the distance to the disposal or treatment site.**

Note that this method does not directly assess the impacts of the final waste disposal activities as these are usually located outside the installation. Instead, a simplified approach is used, based on the Waste Hierarchy. However, where disposal activities are included in the installation, the Operator should refer to the relevant sector guidance for details on the appropriate assessment method.

3.12.1 Characterise the Waste Disposal Method for each Waste Stream

1. **List the waste streams arising from each option and their disposal or treatment method.**(note 1) The waste streams and annual tonnages for each option will have been completed as part of the emissions inventory in module 2.

2. **For each waste stream within each option, quantify the hazard category of the waste before and after treatment by applying the relevant factor below.** **(note 3)**

hazardous	**10**
non-hazardous	**5**
inert	**1**
no residue	**0**

3. **For each waste stream within the option, assign a score according to the waste hierarchy rank of the disposal method, provided in the table below:**

disposal method(note 4)	**score**
composting	**2**
recycling	**3**
chemical recovery	**4**
landspreading	
use of waste as a fuel	**10**
incineration with energy recovery	
inert landfill	**14**
release into water	**17**
sub-surface storage/injection	
incineration without energy recovery	**20**
non-inert landfill	**30**

continued….

continued….

4. **For each waste stream within each option, list the distance in miles from the site of production to the furthest practicable treatment/disposal site.**(note 2) The treatment/disposal site must be one which is legally able to accept and treat the wastes. Apply a value to each distance from the categories below:

0-10 miles	**1**
11-30 miles	**2**
31-50 miles	**3**
51-100 miles	**4**
101-200 miles	**5**
200+ miles	**6**

5. **Present the information according to the format provided in the electronic software tool.**

Notes

1. Waste arisings are those solid or liquid wastes that will be disposed of, with or without prior treatment. Waste is defined as a material which has fallen out of the chain of utility or material which the Operator either discards, intends to discard or is required to discard.

   Any wastes which are re-used or recycled, or any substances in the waste stream which are extracted for re-use or recycling within the activities of the Permit can be disregarded in this assessment.

   The Operator should identify the main treatment/disposal method a waste intends to undergo. It should generally be apparent to the Operator and Regulator what the main treatment is, however, when it is not, the choice of the treatment used in the assessment should be justified by the Operator, by making a reference to the reasoning behind choosing the treatment in the comment section of the assessment spreadsheet. Sector BREFS can be consulted for information on the possible treatment options for each waste stream if further information is required on viable techniques.

2. When assessing distances to waste disposal/treatment sites it is necessary to use some judgement. Do not use the nearest available site, unless you intend to use this site exclusively for the duration of the PPC authorisation being applied for.

   Instead, where there are only a few specialist providers in the UK, use the potential worst case, which could be a more distant facility.

   Where there are many providers in the UK, use your judgement as to the furthest away that you would consider using (e.g. landfill sites with a 50 mile radius from your site, water treatment plants with a 100 mile radius of your site, and so on).

3. The categories are hazardous, non-hazardous, and inert. **Hazardous wastes** are those covered by article 1(4) of the Hazardous Waste Directive (i.e. they fall under the Hazardous Waste List). Note that due to changes to the Special Waste Regulations, it is likely that the term hazardous will include all entries in the European Waste Catalogue. **Non-hazardous wastes** are wastes, which do not fall under the Hazardous Waste List (European Waste Catalogue). Generally this includes biodegradables, unless they contain hazardous substances. **Inert wastes** are defined under the Directive. They do not undergo any significant physical, chemical or biological changes and will not dissolve, burn, or otherwise physically or chemically react, biodegrade or adversely affect other matter which they come into contact with in a way likely to harm the environment or human health.

   Further characterisation of the waste is not required for this methodology.

4. The hierarchy applies to disposal activities that comply with the relevant environmental performance requirements or operate according to recommended good practice guidelines.

3.12.2 Screen out any Insignificant Waste Streams

1. **Waste streams that meet all of the following criteria can be screened from further assessment**:
   - where the treatment/disposal location scores 2 or less on the transport scale;
   - wastes that are non-hazardous or inert; and
   - wastes that are composted, recycled, landspread or recovered for re-use.
2. **Provide an explanation confirming the reason for screening out any waste streams.**

3.12.3 Quantify the Impacts of Disposal of Waste

Hazard Score

1. **For each option, calculate a hazard score by following the guidelines below.** (Note that the electronic software performs these calculation steps).

   For each waste stream:
   - quantify the mass ratio of waste immediately following the treatment or disposal process to the mass before treatment$^{(note\ 1)}$, i.e.:

$$mass\ ratio = \frac{mass\ after\ treatment}{mass\ before\ treatment}$$

   - using the hazard scores assigned in step 3.12.1, quantify the combined hazard of the waste stream by adding the hazard score before treatment or disposal to the hazard score after treatment or disposal.
   - multiply the combined hazard score by the mass ratio to obtain the total hazard score for each waste stream.
   - sum the total hazard score of each waste stream within each option to obtain the overall hazard score for the option.

Treatment & Disposal Score

2. **For each option, calculate a treatment & disposal score by following the guidelines below.**

   For each waste stream:
   - using the values assigned in step 3.12.1, quantify the disposal score by multiplying the waste hierarchy score by the distance to disposal score.
   - sum the disposal score of each waste stream to obtain the overall disposal score for each option.
3. **When conducting options appraisal, rank the options according to the hazard score and the disposal score.** $^{(note\ 2)}$

Notes

1. The mass immediately following disposal or treatment relates to the residues/ wastes leftover when the treatment/disposal is complete. This will vary according to the option chosen: for example, with incineration, the mass after will be the weight of ash; for landfill, the mass will not be reduced immediately, hence the mass after will generally equate to the mass before. The mass after does not include recovered products, such as solvents following solvent recovery, however it does include the residues/sludges separated from the useable solvents.

   When one or more wastes are produced following a disposal or treatment process, all outputs must be considered by mass and hazard. The totals from each output will then be combined to produce a total value for the original waste stream and disposal/treatment option.
2. The Operator should provide additional information, such as local factors, which may influence the decisions made regarding waste disposal. It is envisaged that this may be required in a number of scenarios, such as those given below:

- If two treatment or disposal methods have final scores, which are very close to each other, for local or operational reasons, one method may be more preferable to the Operator than the other. Operators can enter information which will support their reasoning for choosing the option which has not got the lowest score.
- The majority of transport in the UK is by road. For this reason, the assessment is based on road transport; however, there may be cases where rail or barge transport is used. If this is the case, the Operator is given the opportunity to inform the Regulator and allow this to influence the chosen disposal option. Recovery abroad may also be an option for some waste streams and can be discussed here.

MODULE 4: Compare Impacts between Options

Aim

The aim of this module is to compare the overall performance of each option for all the environmental considerations assessed in module 3, in order to identify which option represents the lowest impact on the environment as a whole.

At the end of this module, the Operator should have:

- **resolved any cross-media conflicts that arise between options;**
- **ranked the options according to their environmental benefit;**
- **identified the option with the least environmental impact;**
- **decided whether the option with least environmental impact is BAT, or whether COSTS need to be taken into account.**

4.1 Rank the Options in order of environmental benefit

1. **Compare the information on environmental effects produced in module 3 to prioritise the options in order of least environmental detriment:**

    - For emissions that have defined benchmarks such as EQSs and EALs, this comparison should include both the risk posed by individual substances to breaching an EQS or EAL, as well as the combined impact of emissions affecting each medium.
    - This comparison may be made using the graphical and tabular outputs of the electronic tool, or other method as appropriate.
    - If any of the options results in the lowest (or equal lowest) impact against all of the environmental considerations that option can be considered to be the best option without need for further assessment.

2. **If the best option is self-evident and the Operator proposes to implement it, no further assessment is necessary.** In this case, the best option is assumed to be the Best Available Technique, and the Operator may support the decision by reference to the information on impacts produced in module 3.

3. **The Operator should continue with the assessment if:**
    - it is not possible to rank the options because there are conflicts between relative performance of different environmental considerations between the options; and/or
    - the Operator wishes to take costs into account to decide which option represents the Best Available Technique.

4.2 Resolve Cross-Media Conflicts

1. **Identify and resolve any cross-media conflicts between the options.** This should be done using reasoned judgement, with reference to any decisions or assumptions made over the relative importance of different environmental impacts.(note 1) The following guidelines and examples may be used to assist in the process.

    General considerations, which may be taken into account (where relevant), include:
    - contribution to an environmental benchmark: if the process contribution of a substance is very low in comparison to its benchmark then this will be less important in the decision-making process than when the contribution is high;
    - local environmental quality: where the existing environmental quality is poor, e.g. if an EQS or EAL may be breached, greater importance may be placed on this consideration in the assessment of relative performance;
    - presence of sensitive receptors: greater importance may be given where there is local proximity of receptors or habitats that are particularly sensitive to a substance or its impacts;
    - the nature of the effects: long term irreversible effects may be considered to be worse than short term, reversible ones.
    - highly persistent, bioaccumulative, toxic and carcinogenic substances may be considered priorities over other substances.
    - contribution to any local, national or international plans or targets for the control of specific substances or priority effects, including those identified in any sector plans or pollutant reduction programmes agreed with Regulators

IPPC

Specific guidelines for the more common cross-media conflicts are provided in notes 2 to 5 below.

2. **Rank the options, presenting any judgement of cross-media conflicts in a clear, consistent manner** so that the Regulator and others are readily able to review and audit the proposals. The guidelines should not be applied selectively to support a "favoured" option, but used across all options to produce a balanced judgement that focuses on minimising overall environmental risk.

3. **If the Operator now proposes to implement the option with least environmental impact, having resolved any cross-media conflicts, no further assessment is necessary.**

4. **If the Operator wishes to take costs into account to decide which option represents the Best Available technique, continue to the next module.**

Notes

1. Often the best option is not clear, as different options perform differently against each of the 11 environmental considerations; such that no one option has a clear advantage in all of the considerations. There may be direct trade-offs between an advantage in one category and a disadvantage in another, for example, an increase in global warming potential from energy used to abate a release to air. In these cases, further assessment is required to resolve the conflict between environmental considerations by considering their relative importance.

   Due to the diverse nature of their impacts upon different receptors, there is no single basis upon which all of the environmental considerations can be compared on an aggregated basis. As such the decision-making process must rely on the professional judgement of the Operator and Regulator to balance these diverse environmental considerations and determine which are considered to be of greater environmental priority. This is an installation-specific judgement, which has to take into account not only the technical characteristics, but also the influences of geographical location and local environmental conditions. In exercising professional judgement, the Operator is required to state the reasoning behind the relative importance attached to each of the environmental factors which leads to the selection of BAT.

   Where the best option is not self-evident, the Operator should make a judgement of the relative importance of the environmental considerations in order to rank them. This is a generally a qualitative procedure, particularly if the differences lie between the direct and indirect effects. A structured summary of this decision-making process is provided in the H1 software tool and shown below.

   Each environmental consideration is assigned a degree of importance by the Operator using the low, medium and high scaling, based on the magnitude of environmental risk posed by the options in general. Where a consideration has been screened for all of the options, then it should be marked as not relevant. The Operator should consider both the overall burden for each consideration and also the effects of individual substances, where these could be considered to have a critical influence. For example, where a single substance contributes to a risk of breaching an EQS.

   It is important that these rankings are supported by reasonable justification, for which the general guidelines in section 4.2 above may be of assistance.

environmental consideration		**importance**			**comments / justification**
		low	**med**	**high**	
releases to air	long term				
	short term				
deposition to land					
releases to water	long term				
	short term				
noise					
consequences of accidents					
visual					
odour					
POCP					
GWP					
Disposal of Waste					

Guidelines for Assessing Trade-Offs

2. **Direct impacts AIR/AIR, WATER/WATER, AIR/WATER**

   In these cases, the relative impact of pollutants released to different media in relation to the respective environmental benchmarks (i.e. EALs) can be used to judge relative importance. Releases of different substances to air can be readily compared in this way.

   For example if:

   - the Process Contribution for Lead is 0.1 µg/m^3 and the EAL is 2 µg/m^3 then PC/EAL = 0.05
   - the Process Contribution for formaldehyde is also 0.1 µg/m^3 and the EAL is 5 µg/m^3 then PC/EAL = 0.02

     one would conclude that lead reduction was more important.

It is also valid to compare releases to water and air on this basis since the EALs represent a similar harm based judgement whether they are to air or water. [6]

3. **Trade-off between Global Warming Potential and Air, Water and Deposition Impacts**

Many environmental protection techniques use energy, which results in carbon dioxide emissions (as well as other emissions) leading to global warming potential. The following should be taken into account:

- The environmental effects of energy use cannot often be directly compared with those of other pollutants. Typically, the comparison is of global warming potential against human health effects, aquatic toxicity etc. Therefore, the Operator needs to make a judgement over the priority that should be placed on each of the environmental considerations (see table under Note 1) in deciding the extent to which it is worth expending energy to reduce another pollutant.
- It is generally considered to be worth spending energy to reduce the impacts of other pollutants. However, there has to come a point at which the gains for other pollutants are so small compared with the generation of CO_2 that global warming becomes the more important effect. The Operator should not use increased energy consumption as a reason not to implement other environmental improvements without qualifying this with a judgement of whether the cost and energy-related environmental disadvantages outweigh the other environmental improvements. Arguments for prioritising of global warming effects should be made in the context of overall efforts for improving energy efficiency within the installation. In many cases energy used in environmental protection techniques constitutes a small proportion of total energy consumption and there are often opportunities to improve energy efficiency in other parts of the installation that will outweigh the increase attributed to environmental protection.
- This cross-media trade-off is often taken into account at a sector level when setting indicative best available techniques for the sector. At the site level, the Operator should consider only if any of the options are likely to result in excessive disbenefits of global warming potential compared with typical sector assessments of those techniques.
- A useful method may be to compare the ratio of tonnes of carbon dioxide released through energy against tonnes of other pollutant abated. Further guidance on the relative value of other pollutants versus carbon dioxide is under discussion.
- The closer a pollutant is to the EAL for that substance, the greater the risk of harm and therefore it is not only worth spending more money to control it (the cost/benefit balance of BAT changes) but it is also worth spending more energy and releasing more CO_2. See Module 6, Section 6.1. Thus, for example, if the proposed NOx levels would be unacceptable in the local environment and the alternative is to use energy to control it, it is unlikely that the use of that energy could be used as an argument not to control it.

Example – Flue Gas Desulphurisation on Coal-Fired Power Station

The installation of flue gas desulphurisation techniques on a typical coal-fired power station may result in an additional 1,000 – 1,500 kt of carbon dioxide emissions annually (depending on technique), as a result of additional power consumption and chemical reaction of limestone reagents. However, this represents only a 2.4 – 3.0% increase in the total carbon dioxide releases for the power station, whereas the benefit in terms of acid gas emissions is a reduction of 40 – 90 kt per annum or 90% of unabated sulphur dioxide releases. (See Reference 20).

In this case the benefits in terms of reduction in acute effects to human health and long-range effects of acidification caused by emissions of SO_2 are judged to be a greater priority than the effects of the additional emission of CO_2.

4. **Trade-off between Global Warming Potential and Noise or Odour**

Apart from the use of energy, noise rarely conflicts with other pollutants. Unlike releases to air, land and water which should be reduced to zero if this is economically feasible, releases of noise (and odour) cease to be pollution at the point where they cease to cause a problem (generally when they cease to cause harm to mans' senses). For noise, this point, at which environmental impact can be said to be zero, is usually a figure which relates to the existing background levels. Beyond this point there is little point in further use of energy (or expenditure) to reduce impacts.

5. **Trade-offs between Waste Hazard & Disposal and Local Impacts**

---

[6] Note that proposals for revision of the methodology for the setting of EALs aims to achieve even better consistency in derivation for different media.

Where the waste generated is going to an appropriate engineered landfill it is usually considered to be worth while producing a waste residue in order to reduce other pollutants which result in local impacts. Where the waste is being landspread the landspreading case should stand on its own and show a positive environmental benefit. The cross-media assessment is usually made at the sector level in setting of indicative BAT, and the Operator should focus on any site-specific reasons for deviating from this sector-level judgement.

6. **Trade-off between impacts to air, water or deposition to land**

The impacts to air and water are based on comparison of environmental benchmarks. There are several elements to assessing a trade-off between these media:

- consideration of the risk of any emissions to each medium either breaching an EQS or EAL or affecting a specific receptor sensitive to that emission. If it is the case that the risk is higher for substances released to one medium than the other, then the preferable option may be that with the lower risk.
- consideration of the total impact to the medium. This should be specified by receptor type. Ideally, for each medium, there would be benchmarks of harm for both human and ecological receptors. The reality is that insufficient information is available to generate this information currently, and the H1 guidance for reasons of practicality uses the best available data sets for each medium. In practice this means that emissions to air are largely based on human health impacts (although there are a few benchmarks for ecological receptors) and for water, the benchmarks are based on ecotoxicity in the aquatic environment. In addition, the benchmarks incorporate different safety factors. (The Environment Agency intends to consult on a revised methodology for derivation of EALs that will provide a more consistent approach and aid comparison between media). Thus a comparison between impacts of emissions to air and emissions to water is largely between a human health effect and an ecological effect. These are not directly comparable, so the relative importance may be judged in relation to presence of particularly sensitive population groups or particularly sensitive ecological receptors that could be affected.
- In addition, there may be substances released to either air or water that have been identified as priorities for control under a local, national or international plan. Whilst it will always be relevant to consider local circumstances, such plans may be used to indicate preference for options which reduce the contribution to the release of these substances.

In summary, the Operator will need to provide a justification for the ranking taking into account the above guidelines in combination.

MODULE 5: Evaluate the Costs

Note

This module requires completion only when conducting an appraisal of BAT for more than one option. It is not required for the assessment of environmental impact of the installation.

Aim

The aim of this module is to estimate the costs of implementing each of the options carried forward from MODULE 4, in order that a balanced judgement of the costs of controlling releases of pollution against the environmental benefits can be made.

If an Operator proposes to implement the option that is demonstrated through the appraisal methodology of Module 4 clearly to represent the lowest environmental impact, the evaluation of costs to implement the option is not necessary.

The following guidance presents a consistent format which Applicants should follow when presenting financial and economic information on the costs and cost-effectiveness of techniques. The Regulators need this information to be provided in sufficient detail to determine whether the Operator's proposals regarding the selection of Best Available Techniques are justified.(note 1)

1. **For each option to be considered in the appraisal, provide estimates of the following costs:**
   - capital costs of equipment purchase and installation,(note 2)
   - average change in annual operating and maintenance costs.(note 3)

   The information for capital and operating costs should be provided according to the templates shown overleaf and which are included in the software tool. The costs should be broken down into sufficient detail to allow the major cost influences of each option to be clearly demonstrated.(note 4)

2. **Calculate the annualised cost for each option according to the following method** (note 5): (note that these calculation steps are included in the H1 software tool)

Step	Result	Units
Discount rate, r (note 6)	=	decimal
Assumed life of the option, n (note 7)	=	years
Equivalent annual cost factor = $\frac{r}{(1+r)^n-1}+r$	=	
Present value factor = 1 / equivalent annual cost factor	=	
Present value cost of the option = (Annual average operating costs x **present value factor)** + capital costs (Note 1)	=	£
Equivalent annual cost = **Present value cost of the option** x **equivalent annual cost factor**.	=	£

3. **Present the information according to the table below:**

EQUIVALENT ANNUAL COSTS		
	Option 1	**Option 2, etc.**
Capital Cost (£ '000s)		
Operating costs (£ '000s / year)		
Life of option (n) (years)		
Discount rate (r)		
Equivalent annual cost (£ '000s)		

Notes

1. In order that cost appraisals can be assessed on a consistent basis between installations and sectors, a standard methodology for the reporting of costs has been developed. This is based on guidelines issued by the European Environment Agency "Guidelines for Defining and Documenting Data on Costs of Possible Environmental Protection Measures" (see Reference 21).

2. Capital costs include all costs required to purchase equipment needed for the pollution control techniques, the costs of labour and materials for installing that equipment, costs of site preparation (including dismantling) and buildings and certain other indirect installation costs. Capital costs should include not only those associated with stand-alone pollution control equipment, but also costs of making integrated process changes or installing control and monitoring systems.

   The limits of the activity or components to which the costs apply should be described. For example, choice of one type of technology, which is inherently less polluting, would require all components of that technology to be included in this limit.

   "Engineering" estimates of costs are generally satisfactory for cost submissions. However, any significant uncertainties should be described, especially for components that could have a major influence on a decision between different options. Where available, the cost of each major piece of equipment should be documented, with data supplied by an equipment vendor or a referenced source.

   If capital costs spread over more than one year, reduce these to the present value in first year, as illustrated in the example below:

Year	1	2	3
Capital expenditure	**2000**	**2000**	**2000**
Discount rate		**10%**	**10%**
Value today	**2000**	**2000 x 0.9**	**2000 x 0.9 x 0.9**
Equals	**2000**	**1800**	**1620**
Present value in first year	**5420**		

   Where end-of-life and decommissioning costs are included, these should usually be discounted to a present value. Further guidance is provided in the Decommissioning Guidance (see Reference 22).

3. The recurring annual change in operating costs for options consists of the additional costs, minus any cost savings, resulting from the implementation of that option. This should include any changes in production capacity. The recurring annual costs for pollution control systems consist of three elements:

   - direct (variable and semi-variable) costs,
   - indirect (fixed) costs, and
   - recovery credits.

   Direct costs are those which tend to be proportional or partially proportional to the quantity of releases processed by the control system per unit time or, in the case of cleaner processes, the amount of material processed or manufactured per unit time. They include costs for raw materials, utilities (steam, electricity, process and cooling water etc.), waste treatment and disposal, maintenance materials, replacement parts, and operating, supervisory, and maintenance labour.

   Indirect, or "fixed", annual costs are those whose values are totally independent of the release flow rate and which would in fact be incurred even if the pollution control system were shut down. They include such categories as overhead, administrative charges, insurance, and business rates.

   Direct and indirect annual costs may be offset by recovery credits, taken for materials or energy recovered by the control system, which may be sold, recycled to the process, or reused elsewhere at the site. These credits, in turn, should be offset by the costs necessary for their processing, storage, transportation, and any other steps required to make the recovered materials or energy reusable or resaleable. They also include reduced labour requirements, enhanced production efficiencies or improvements to product quality.

4. **The templates provided present a detailed breakdown of the components that contribute to capital and operating costs. The Operator is required to provide sufficient cost breakdown information to allow comparison of the contribution of component techniques within each option, particularly where components differ significantly between options. The components listed are based on a general format, but where relevant, the Operator may present a cost breakdown based on components more appropriate to the particular industrial sector of the activity.**

   If the exact cost figures are not available for the detailed breakdown, and are not required for the purposes of clarification of differences between options, the Operator should indicate which cost elements are included in the total by placing a tick against the relevant component. This ensures consistency in the determination of applications.

   In certain cases, the Operator may wish to apply for confidentiality of cost information. This must be done on a case by case basis. In any event, the Agency may require access to actual cost information in order to determine the application. However, subject to the satisfaction of the Regulator, cost information may ultimately be submitted as part of this BAT assessment in the form of relative costs.

5. The preferred technique for appraisal of options is based on conventional discounted cash flow (DCF) analysis, which allows options of different timescales and cost profiles to be compared on the same basis. In DCF the future cash flows over the lifetime of an option are converted, or “discounted” to annualised values or “equivalent annual costs”.

6. The Operator should select an appropriate discount rate. This usually reflects the cost of capital to the Operator. Internal “hurdle” rates are not appropriate for the costing of environmental protection measures as these often assume an over-optimistic return on investment due to a need to compete with other projects. **Typical “real” rates vary between 6% and 12% depending on the risk associated with the company, industrial sector or project. The Operator should justify the selection of the discount rate, especially if it is above this range. The same discount rate should be used for all options.**

   The discount rate, r, should be expressed as a decimal when used in the calculation for equivalent annual costs factor.

   Where decommissioning costs are included, it is often appropriate to assume a lower discount rate to these costs than that assumed for the rest of the project. This is because the uncertainty associated with estimates of decommissioning costs is such that they are more likely to be substantially underestimated than overestimated, leading to bias in the cost assumptions. A first approximation of the discount rate to use for decommissioning can be estimated by subtracting a “decommissioning risk premium”. See the Decommissioning Guidance (Reference 22) for further information.

7. The assumed life of the option should be based on asset life. Some general guidelines on typical plant life are provided below, and more specific information may be obtained from Sector Guidance Notes.

Buildings	**20 years**
Major components **(e.g. reactor vessels, furnaces, boilers, turbines, effluent treatment plant)**	**15 years**
Intermediate components **(e.g. heat exchangers, filters, handling equipment)**	**10 years**
Minor components **(e.g. motors, drives, burners)**	**5 years**

Where the Operator has used other factors or methods to those described above a justification for their use should be included.

CAPITAL/ INVESTMENT COSTS			
Break down	indicate whether component is Included in Capital Costs Yes / No	Costs £ 000's/ % of total capital cost/ Other (please specify units)	Year
Pollution control equipment costs break down : • primary pollution control equipment • auxiliary equipment • instrumentation • modifications to existing equipment			
Installation costs: break down: • Land costs • General site preparation • Buildings and civil works (e.g. foundations/ supports, electrical, piping, insulation etc) • Labour and materials (engineering, construction and field expenses)			
Other capital costs: • Project definition, design and planning Testing and start-up costs • Contingency • Working Capital • End of Life - Clean up costs (note: this cost would be typically discounted to a present value)			
Total Capital costs			

OPERATING COSTS & REVENUES

Break-down:	Indicate if included in Operating Costs Yes / No	Quantity (please specify units e.g. N^{o} Full time staff*, tonnes etc.)	Cost/ Value per Unit	Total Cost/ £ 000's per year / % of total operating cost/ Other (please specify units)	Year
Additional Costs: Break-down: • Additional labour for operation and maintenance • Water/ Sewage • Fuel/ Energy costs Please specify energy/ fuel type: • Waste Treatment and Disposal • Other materials and parts Details: • Costs of any additional pollution abatement equipment operation Details: • Insurance • Taxes on Property • Other general overheads					
Cost Savings/ Revenues: Break-down • Energy savings • By-products recovered/ sold • Environmental tax/ charge savings • Other					
Total Operating Costs					

MODULE 6: Select Best Available Techniques

Aim

The aim of this module is to identify the best available technique from the candidate options, by balancing the environmental benefits of each option against the costs of achieving them.

The selection of the option that represents the Best Available Technique involves consideration of the environmental and economic information generated in the previous modules. The Operator should apply reasoned judgement to make this decision, although some guidelines and other tools as described in this module, are available to assist in the decision-making process.

6.1 Identify the Option which Represents BAT

1. **Identify the option that represents BAT for the activity or installation, by making a comparative assessment of environmental advantages and costs between options. Guidelines are provided in the notes below.** (note 1)
2. **Provide a brief summary to support this decision, which should include:**
   - decisions made at earlier stages within this methodology;
   - the methods used to compare costs and benefits; (note 2)
   - assumptions made on relative importance of environmental considerations;
   - the sensitivity of the decision to any uncertainties in data or assumptions. (note 3)

   A clear audit trail for the decisions made should be provided. This is done, most easily, by providing a supplementary document that refers to the environmental impact and cost information provided in the H1 software tool.

Notes

Identify the major influences in decision making

1. The choice of installation-specific Best Available Techniques involves a consideration of economic and environmental information generated in the previous modules. In **Module 4,** the Operator summarises the impacts of each option against a range of environmental considerations, in order to judge relative performance and identify which option represents lowest impact on the environment as a whole.

   Once the options have been ranked according to environmental performance, the option that results in the lowest impact on the environment as a whole will usually be BAT, unless economic considerations mean that it is unavailable. The principal consideration in determining whether an option represents BAT is that the costs of its implementation should not be disproportionate to the environmental benefit it realises. Thus it may not be reasonable to implement an option of significantly higher cost which achieves only a marginal environmental improvement compared with another option.

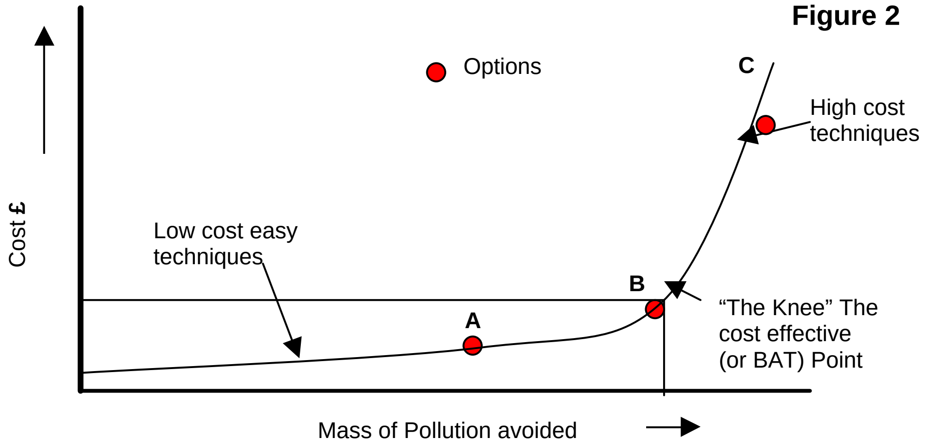
Techniques to balance costs and environmental benefits

2. An objective judgement needs to be taken to balancing costs and advantages when assessing what is BAT. There are several ways this judgement may be carried out, depending on the complexity of the situation. For example, in some situations, the environmental benefits of different options may be based on the control of a single or dominant pollutant. This provides a common cost/benefit factor that can be used for comparison of options, such as “cost of preventing emission of 1 tonne of pollutant”. However, there are other situations where the benefits are more complex eg involve different pollutants or media. In these cases the Operator may need to apply further expert judgement to identify the more important environmental risks and the value of their control. Examples of approaches to cost/benefit assessment are provided below.

   dominant pollutant or environmental impact

   In some cases, the environmental benefit of the option can be represented readily by a single pollutant (eg the control of NOx ,CO_2 ,Hg) or a group of pollutants with similar effects to one medium and receptor (eg EQ_{air} (human health), EQ_{water} (aquatic toxicity)). Where there are several options it may be possible to plot a curve of cost against environmental benefit. With 3 or more points it may be possible to identify the point, after which, the cost of abatement (£/tonne abated) increases significantly, as shown Figure 2.

Figure 2



This type of analysis indicates the point at which it is becoming increasingly expensive to make improvements (value for money is decreasing rapidly). On Figure 2 this would be located around technique B.

In other cases the environmental benefits of different options may involve dissimilar pollutants, media or environmental effects or a combination of pollutants and effects in which no single effect dominates. In such cases it is not usually possible to aggregate the "environmental advantages" on a common basis and the assessment is more complex.

In these cases the Operator needs to compare the combined benefits of each option by considering the relative importance of the environmental consideration as already carried out in module 4. The priorities identified in module 4 should be used as the main environmental indicators in the cost / benefit judgement. It may be necessary to **In most cases the main issues come down to one or two substances, making such judgements feasible**.

The following considerations and assessment tools (some of which were also referred to in **Module 4**) may be used in appropriate circumstances:

- Comparison of predicted environmental concentration with an EAL or EQS. This shows which option is most sensitive in the context of the "headroom" between the PEC and the EAL. This may indicate a need to give a higher priority to the effects of one particular option.

  E.g. where installation is a contributor to an EQS which is under threat, it is worth spending more (per unit abated) to avoid the "harm" threshold.

- Consideration of sensitive receptors. In addition to compliance with relevant EQSs and comparison with EALs, Operators should consider the consequences of releases on any particularly sensitive receptors in the receiving environment.

  E.g. an EQS may not be threatened, but the presence of a particular sensitive species in an adjacent SSSI may lead to the need to "go further" because of special site circumstances.

Judgement of cost effectiveness

It is not an objective assessment of how much it is worth spending to reduce a given mass of pollution. The Agency is working to develop tools to further assist this decision making process (such as a database of actual costs and pollution reduction for a number of substances).

- Comparison may be made of incremental annualised costs of each process option with the incremental change in an environmental effect. For existing processes, this should be based on the marginal costs and benefits over the existing or "base case".

  E.g. the **cost effectiveness** of going from:

  - Option A (existing base case) to Option B is £x/tonne or £x/unit EQ
  - Option A (existing base case) to Option C is £y/tonne or £y/unit EQ

  For new processes, a direct comparison between the total annualised costs and the environmental benefits can be made to rank the options in order of cost-effectiveness, e.g.

  - Option A is £x/tonne or £x/unit EQ
  - Option B is £y/tonne or £y/unit EQ
  - Option C is £z/tonne or £z/unit EQ

- Comparison of more than one environmental consideration by the incremental cost method above may be used where more than one environmental consideration is important. If BAT turns out to vary according to the environmental effect used, then the Operator should either justify his final choice with reference to the most important effect, or combine relevant techniques from each potential BAT to produce an option that would be the BAT with respect to all environmental effects.
- Comparison of the unit costs of pollution control for each option with a cost benchmark for that substance. The Agency is developing a control cost database to generate typical cost ranges for control of certain key pollutants; e.g. if it were established that it was worth spending £3000/tonne to reduce NOx then there would be a clear method for deciding whether to carry out Options A, B or C above.[7]

The assessment of the various environmental factors is complex and must inevitably rely on professional judgement to identify the option which represents the installation-specific Best Available Techniques. Whichever option the Operator believes represents BAT and however that decision has been arrived at, that decision should be justified by clearly setting out the environmental factors that were most important and showing how the final ranking of the options and choice of BAT was made.

3. Throughout the assessment, uncertainties about many of the assumptions made could influence the results of the assessment. This does not necessarily invalidate the methodology used to undertake the assessment, but highlights the importance of sensitivity analysis as a technique to explore the influence of these uncertainties. Sensitivity analysis involves varying the values of parameters used on the assessment within reasonably expected bounds and analysing how alternative assumptions could change the results of the assessment. Such a technique might need to be used at various stages of the assessment, including, for example, the identification of significant releases, where assumptions about the amount of substances released could be important, as well as the assessment of the environmental and economic effects of the various options, to test the robustness of the results to possible alternative assumptions.

Availability of Capital

If an option is judged to represent BAT, it should be implemented within a reasonable timescale. This may depend on the availability of investment capital to the Operator and the amount required. Where there is more than one environmental protection project requiring investment, and capital is limited, the Operator should agree a priority for implementation of the techniques with the Regulator. Priority should usually be given to those projects yielding the greatest environmental benefits.

---

[7] Some cost benchmark data are available and advice should be sought from the local Regulator.

REFERENCES AND DEFINITIONS

For a full list of available Technical Guidance see Appendix A of the *Guide for Applicants* or visit the Environment Agency Website http://www.environment-agency.gov.uk. Many of the references below are being made available free of charge for viewing or download on the Website. The same information can also be accessed via the SEPA web site http://www.sepa.org, or the NIEHS web site www.ehsni.gov.uk**.** Most titles will also be available in hard copy from The Stationery Office (TSO). Some existing titles are not yet available on the Website but can be obtained from TSO.

1. The Pollution Prevention and Control Act (1999) (www.uk-legislation.hmso.gov.uk).
2. The Pollution Prevention and Control Regulations (SI 1973 2000) (www.uk-legislation.hmso.gov.uk).
3. IPC E1 BPEO Assessment Methodology for IPC The Stationary Office ISBN 0 10 542499
4. IPPC Part A(1) Installations: Guide for Applicants (EA Website).
5. IPPC: A Practical Guide (for England and Wales) (or equivalents in Scotland and Northern Ireland) (www.environment.detr.gov.uk).
6. Guidelines for Environmental Risk Assessment and Management, July 2001, DETR, Environment Agency, Institute of Environmental Health, The Stationery Office ISBN 0 11 753551 6
7. IPPC H2 Energy Efficiency Guidance Note (post -consultation working draft on EA web-site)
8. IPPC H3 Noise Guidance Note (consultation draft on EA Website)
9. IPPC H4 Odour Guidance Note (in preparation for consultation: in the interim, consult the Regulator)
10. IPPC Regulatory Guidance Series No 1 The Determination and Implications of “Change in Operation” and “substantial Change” (available via the Regulator)
11. Protocol for the Environmental Evaluation of Achievable Releases in Chief Inspector’s Guidance Notes, WS Atkins Environment Report No E5251-R1, HMIP, 1995
12. “Ambient Data” (Environment Agency document in preparation)
13. Perriman, R, “Assessment of Significance”, EAC report to the Environment Agency, 2000.
14. Turner D B, “Workbook of Atmospheric Dispersion Estimates: An Introduction to Dispersion Modelling, Lewis Publishers,1994
15. Technical Guidance Note (Dispersion) D1, Her Majesty’s Inspectorate of Pollution, June 1993 (The Stationery Office)
16. Chimney Heights: Third Edition of the 1956 Clean Air Act, (The Stationery Office)
17. Jones JA, 1983, Models to allow for the effects of coastal sites, plume rise and buildings on the dispersion of radionuclides and guidance on the value of deposition velocity and washout coefficients NRPB-R157
18. UNECE (1991) Protocol to the 1979 Convention on Long-range transboundary air pollution concerning the control of emissions of volatile organic compounds or their transboundary fluxes. Geneva, 18 November 1991
19. IPPC (1994) Radiative Forcing of Climate Change, Report of the Scientific Assessment Working Group of IPPC. Summary for Policymakers.
20. The Costs and Benefits of Applying the Emission Limit Values in a Proposed Amendment to the Large Combustion Plant Directive, Final Report to the DETR (now DEFRA), Entec, April 1999.
21. Guidelines for Defining and Documenting Data on Costs of Possible Environmental Protection Measures, EuropeanEnvironment Agency, Technical Report no 27
22. Decommissioning Guidance (Environment Agency document in preparation)
23. EH40/2001 Occupational Exposure Limits 2001, HSE ISBN 0 7176 1977 X
24. WHO “Assessing human health risks of chemicals: derivation of guidance values for health based exposure limits” Environmental Health criteria 170, WHO Geneva
25. Davis, RD “Control of contamination problems in the treatment and disposal of sewage sludge” Technical Report no TR 156, Water Research Centre, Medmenham
26. McGrath SP, Loveland PJ “The Soil Geochemical Atlas of England & Wales” Blackie Academic and Professional, London
27. UK Direct Toxicity Assessment Demonstration Programme: Technical Guidance – Addressing Water Quality problems in catchments where acute toxicity is an issue, Report No 00/TX/02/07, UKWIR 2000.
28. Derwent, RG; Jenkin, ME; Saunders, SM; and Pilling, MJ ; Photochemical Ozone Creation Potential for Organic Compounds in Northwest Europe Calculated with a Master Chemical Mechanism, Atmospheric Environment Vol 32, No 14/15 1998, Elsevier Science Ltd
29. []

30. Jenkin, ME; Hayman, DH; Photochemical Ozone Creation Potential for Oxygenated Volatile Organic Compounds: Sensitivity to Variations in Kinetic and Mechanistic Parameters, Atmospheric Environment Vol 33, 1999, Elsevier Science Ltd

List of Abbreviations and Glossary

ADMS	a proprietary air dispersion modelling software package
AQMP	air quality management plan
BAT	Best Available Techniques
BATNEEC	Best Available Techniques Not Entailing Excessive Costs
BPEO	Best Practicable Environmental Option
BREF	BAT Reference (document produced by the European IPPC Bureau)
CFC	Chlorofluorocarbon
CHP	Combined Heat and Power
DTA	Direct Toxicity Assessment
EAL	Environmental Assessment Level (a non-statutory benchmark of concentration for a substance after dispersion into the receiving environment, set at a level below which no harm is likely, derived by the methodologies described in Appendix D of this document.)
ELV	Emission Limit Value (A concentration limit, usually expressed in terms of mass per unit volume. Statutory ELVs, which must not be exceeded, exist for some substances.)
EPAQS	Expert Panel on Air Quality Standards
EQ	Environmental Quotient (a method of relating the contribution of an emission to
EQS	Environmental Quality Standard (a statutory benchmark of concentration for a substance after dispersion the receiving environment, set at a level below which no harm is likely)
FGR	Flue Gas Recirculation (a technique for NOx control in combustion plant)
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
IPPC	Integrated Pollution Prevention and Control
PPC	Pollution Prevention and Control
IPC	Integrated Pollution Control
MAC	maximum allowable concentration
MEL	maximum exposure limit
OEL	Occupational exposure limit
PC	Process Contribution (the concentration of a pollutant after dispersion into the receiving environment)
PEC	Predicted Environmental Concentration (the combined concentration of the PC added to an assumed background level of the same pollutant)
POCP	Photochemical Ozone Creation Potential
SCR	Selective Catalytic Reduction
SNCR	Selective Non-Catalytic Reduction
TGN	Technical Guidance Note
VOC	volatile organic compounds

For noise level definitions, see reference 8, IPPC H3 Noise Guidance.

APPENDIX A: CONSIDERATIONS FOR BEST AVAILABLE TECHNIQUES

Schedule 2 to Regulation 3 of SI 1973 The PPC Regulations, 2000

1. the use of low waste technology
2. the use of less hazardous substances
3. the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate
4. comparable processes, facilities or methods of operation which have been tried with success on an industrial scale
5. technological advances and changes in scientific knowledge and understanding
6. the nature, effects and volume of the emissions concerned
7. the commissioning dates for new or existing installations or mobile plant
8. the length of time needed to introduce the best available technique
9. the consumption and nature of raw materials (including water) used in the process and the energy efficiency of the process
10. the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it
11. the need to prevent accidents and to minimise the consequences for the environment
12. the information published by the Commission (e.g. BREF documents) or by international organisations

APPENDIX B: ENERGY EMISSIONS FACTORS

Direct and indirect emissions of carbon dioxide can be calculated using the factors provided in the Table below, or, where applicable, by the use of factors derived from on-site heat and/or power generation. The values in this table are consistent with factors used for climate change levy and negotiated agreements.

Fuel	**emission factor: Carbon dioxide**	
	kg / MWh	**kg/GJ**
electricity*	166	46.2
coal	300	83.2
coke	430	119.2
gas oil	250	69.3
heavy fuel oil	260	72.2
petrol	240	66.7
liquid petroleum gas	230	63.8
jet kerosene	240	66.7
ethane	200	55.7
naphtha	260	72.2
refinery gas	200	19.1
petroleum coke	340	94.6
natural gas	190	52.8

1 tonne carbon = 44/12 tonnes of CO_2 **1MWh = 3.6 GJ**

Notes *** By convention and for consistency with government schemes, the data is presented as primary energy, ie based on the thermal input to conversion processes generating heat and/or power, whether these be direct conversion at the installation or input to the national grid electricity supply. Note that a proportion of power generation is supplied by nuclear capacity which has a zero carbon input and this results in a relatively low primary factor for electricity. However, where Operators import electricity from the grid, they must also take into account the efficiency of converting the thermal input into electrical output. A high proportion of the national electricity supply is from large generators that have a relatively low thermal efficiency.**

Therefore, to convert the primary energy figure shown here for electricity, Operators must also multiply by a factor of 2.6 to take efficiency losses into account.

For example:
100MWh electricity from national supply x 2.6 x 166 = 43,160 kg carbon dioxide emissions.

The Operator should specify the appropriate factor for other electricity and heat supplies, e.g. direct supplies from CHPs or energy from waste. Further information is provided in Horizontal Guidance H2 Energy Efficiency.

Where heat and power is sourced from a renewable source, this can be assigned a zero carbon dioxide value. Renewable non-fossil energy sources include biomass, landfill gas, sewage treatment plant gas and biogas. Biomass means the biodegradeable fraction of products, waste and residues from agriculture (including vegetable and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste.

APPENDIX C: MAIN POLLUTING SUBSTANCES

Schedule 5 to Regulation 12(2) of the PPC Regulations 2000

POLLUTANTS

Indicative list of the main polluting substances to be taken into account if they are relevant for fixing emissions limit values

AIR

1. Sulphur dioxide and other sulphur compounds
2. Oxides of nitrogen and other nitrogen compounds
3. Carbon Monoxide
4. Volatile organic compounds
5. Metals and their compounds
6. Dust
7. Asbestos (suspended particulates, fibres)
8. Chlorine and its compounds
9. Fluorine and its compounds
10. Arsenic and its compounds
11. Cyanides
12. Substances and preparations which have been proved to posses carcinogenic or mutagenic properties or properties which may affect reproduction via the air
13. Polychlorinated dibenzodioxins and polychlorinated dibenzofurans

WATER

1. Organohalogen compounds and substances which may form such compounds in the aquatic environment
2. Organophosphate compounds
3. Organotin compounds
4. Substances and preparations which have been proved to possess carcinogenic or mutagenic properties or properties which may affect reproduction via the aquatic environment
5. Persistent hydrocarbons and persistent and bioaccumulable organic toxic substances
6. Cyanides
7. Metals and their compounds
8. Arsenic and its compounds
9. Biocides and plant health products
10. Materials in suspension
11. Substances which contribute to eutrophication (in particular, nitrates and phosphates)
12. Substances which have an unfavourable influence on the oxygen balance (and can be measured using parameters such as BOD, COD, etc.)

APPENDIX D - ENVIRONMENTAL BENCHMARKS

Table D1: Environmental Quality Standards for Air Pollutants - Protection of Human Health

EQS or EALs may be revised over time, due to new legislation or new scientific information. The Regulators will update the data in this guidance from time to time, and the Operator should ensure that they use the most up to date of these benchmarks.

Substance	Reference Period	EC-Daughter Directive Standards***		UK Air Quality Regulations Objectives**	
		Limit Value	Date by which limit value is to be met	Limit Value	Date by which limit value is to be met
Sulphur Dioxide	Hourly Mean	350 μg/m^3 Exceeded no more than 24 times a year	1 Jan 2005	350μg/m^3 exceeded no more than 24 times per year	31 Dec 2004
	Daily Mean (24 hours)	125μg/m^3 exceeded no more than 3 times per year	1 Jan 2005	125 μg/m^3 exceeded no more than 3 times per year	31 Dec 2004
	15 minute mean			266 μg/m^3 exceeded no more than 35 times per year	31 Dec 2005
Particulate Matter (PM_{10})	Daily Mean (24 hours)	50 μg/m^3 Exceeded no more than 35 times a year	1 Jan 2005	50 μg/m^3 exceeded no more than 35 times per year	31 Dec 2004
		50 μg/m^3 Exceeded no more than 7 times a year	1 Jan 2010		
	Annual Mean	40μg/m^3	1 Jan 2005	40 μg/m^3	31 Dec 2004
		20μg/m^3	1 Jan 2010		
Nitrogen Dioxide	Hourly mean	200μg/m^3 Exceeded no more than 18 times a year	1 Jan 2010	200 μg/m^3 exceeded no more than 18 times per year	31 Dec 2005
	Annual mean	40 μg/m^3	1 Jan 2010	40 μg/m^3	31 Dec 2005

APPENDIX D

ENVIRONMENTAL BENCHMARKS

Air

Substance	Reference Period	EC-Daughter Directive Standards***		UK Air Quality Regulations Objectives**	
		Limit Value	Date by which limit value is to be met	Limit Value	Date by which limit value is to be met
Ozone		120 $\mu g/m^3$* Exceeded no more than 20 days a year averaged over 3 years	2010		
	daily maximum of running 8 hour mean			100$\mu g/m^3$ Not exceeded more than 10 times per year	31 Dec 2005
Carbon monoxide	8 hr mean	10 mg/m^3	1 Jan 2005		31 Dec 2003
	running 8 hour mean			11.6 mg/m^3	
Benzene	Annual mean	5 $\mu g/m^3$	1 Jan 2010		31 Dec 2003
	Running annual mean			16.25 $\mu g/m^3$	
Lead	Annual mean	0.5 $\mu g/m^3$	1 Jan 2005	0.5 $\mu g/m^3$	31 Dec 2004
				0.25 $\mu g/m^3$	31 Dec 2008
1,3-Butadiene	Running annual mean			2.25 $\mu g/m^3$	31 Dec 2003

* Non-mandatory target value, COM(99) 125

** The Air Quality (England) Regulations 2000 (SI 2000 No. 928), Air Quality (Wales) Regulations 2000 (SI 2000 No. 1940, W.138), ….

*** EC Daughter Directives (99/30/EC)

Table D2: National Objectives for the Protection of Vegetation and Ecosystems

EQS or EALs may be revised over time, due to new legislation or new scientific information. The Regulators will update the data in this guidance from time to time, and the Operator should ensure that they use the most up to date of these benchmarks.

Pollutant	Concentration	Measured as	Date to be achieved by
Nitrogen oxides (as NO_2)	30 µg/m^3	Annual mean	31 Dec 2000
Sulphur dioxide	20 µg/m^3	Annual mean	31 Dec 2000
	20 µg/m^3	Winter average (1 Oct to 31 March)	31 Dec 2000

Reference should be made to the Air Quality Strategy (see Reference 14) for information on the situations in which these values apply.

Table D3: Critical Levels for the Protection of Vegetation and Ecosystems

EQS or EALs may be revised over time, due to new legislation or new scientific information. The Regulators will update the data in this guidance from time to time, and the Operator should ensure that they use the most up to date of these benchmarks.

Pollutant	Concentration µg/m^3	Measured as:
Ammonia	3300	hourly
	270	daily
	23	monthly
	8	annual mean

Source: WHO (1994) Working Group on Ecological Effects, Les Diablerets, Switzerland
These levels should be applied where there are sensitive sites, based on a toxicological model including factors to protect 95% of species.

APPENDIX D
ENVIRONMENTAL BENCHMARKS
Air

Table D4: Environmental Assessment Levels for Air (for the protection of human health)

EQS or EALs may be revised over time, due to new legislation or new scientific information. The Regulators will update the data in this guidance from time to time, and the Operator should ensure that they use the most up to date of these benchmarks.

Substance	Long term EAL$^{(note\ a)}$, µg/m^3	Short term EAL$^{(note\ b)}$, µg/m^3
Acetaldehyde	370	9200
Acetic acid	250	3700
Acetic anhydride	1	40
Acetone	18100	362000
Acetonitrile	680	10200
o-Acetylsalicylic acid	50	1500*
Acrylaldehyde	2.3	70
Acrylamide	0.6	18*
Acrylic acid	300	6000
Acrylonitrile	8.8	264*
Aldrin (ISO)	2.5	75
Allyl alcohol	48	970
Allyl-2,3-epoxypropyl ether	240	4700
Aluminium alkyl compounds	20	600*
2-Aminoethanol	76	1500
Ammonia	180	2500
Ammonium sulphamidate	100	2000
Aniline	8	240*
Anisidines, o- and p- isomers	5.1	153*
Antimony and compounds (as Sb) except antimony trisulphide and antimony trioxide	5	150*
Arsenic and compounds (as As)	0.2	15*
Arsine	1.6	48*
Azinphos-methyl (ISO)	2	60
Azodicarbonamide	2	60
Barium compounds, soluble (as Ba)	5	150*
Benomyl (ISO)	100	1500
Benzene	16.25(c,d)	208*
Benzenethiol	23	690*
Benzene-1,2,4-tricarboxylic acid, 1,2-anhydride	0.4	12
Benzo-a-pyrene	0.00025(c)	
p-Benzoquinone	4.5	130
Benzyl butyl phthalate	50	1500*
Benzylchloride	5.2	158*
Beryllium and compounds (as Be)	0.004	0.12*
Biphenyl	13	380
Bis(chloromethyl)ether	0.01	0.3*
Bis(2,3-epoxypropyl)ether	5.4	54*
Bis(2-ethylhexyl)phthalate	50	1000
Bornan-2-one	130	1900
Boron tribromide		1000
Boron trifluoride		280
Bromacil (ISO)	110	2200
Bromine	6.6	200
Bromine pentafluoride	7.3	220
Bromochloromethane	10800	134000
Bromoethane	9060	113000
Bromoform	53	1590*
Bromomethane	200	5900
Bromotrifluoromethane	61900	743000
Buta-1,3-diene	2.25(c,d)	1320*
Butane	14500	181000
Butan-1-ol		15400
Butan-2-ol	3080	46200

Substance	**Long term EAL$^{(note\ a)}$, µg/m^3**	**Short term EAL$^{(note\ b)}$, µg/m^3**
Butan-2-one	6000	89900
2-Butoxyethanol	1230	
Butyl acetate	7240	96600
sec-Butyl acetate	9660	121000
tert-Butyl acetate	9600	121000
Butyl acrylate	530	15900*
n-Butylamine		1500
n-Butyl chloroformate	57	1710*
n-Butyl glycidyl ether	1350	40500*
Butyl lactate	300	9000*
2-sec-Butylphenol	310	9300*
Cadmium and its compounds (as Cd)	0.005(e)	1.5*
Caesium hydroxide	20	600*
Calcium cyanamide	5	100
Calcium hydroxide	50	1500*
Calcium oxide	20	600*
Captafol (ISO)	1	30*
Captan (ISO)	50	1500
Carbofuran (ISO)	1	1000*
Carbon black	35	700
Carbon disulphide	64 (e, f)	100
Carbon monoxide	350	10,000 (see Table D1)
Carbon tetrachloride	130	3900*
Chlorine	15	290
Chlorine dioxide	2.8	84
Chlorine trifluoride		38
Chloroacetaldehyde		330
2-Chloroacetophenone	3.2	96*
Chlorobenzene	2340	70200*
2-Chlorobuta-1,3-diene	370	11100*
Chlorodifluoromethane	35900	1077000*
1-Chloro-2,3-epoxypropane	4.75	145
Chloroethane	27000	338000
2-Chloroethanol		340*
Chloroform	99	2970*
Chloromethane	1050	21000
1-Chloro-4-nitrobenzene	10	200
Chloropentafluoroethane	64200	1
Chlorosulphonic acid	10	300*
2-Chlorotoluene	2640	79200*
2-Chloro-6-(trichloromethyl)pyridine	100	2000
Chlorpyrifos (ISO)	2	60
Chromium, chromium (II) compounds and chromium (III) compounds (as Cr)	5	150*
Chromium (VI) compounds (as Cr)	0.1	3*
Cobalt and cmds (as Co)	0.2	6*
Copper fume	2	60*
Copper dusts and mists (as CU)	10	200
Cresols, all isomers	220	6600*
Cryofluorane (INN)	71100	889000
Cumene	1250	37500
Cyanamide	20	600*
Cyanides, except HCN, cyanogen and cyanogen chloride, (as CN)	50	1500*
Cyanogen chloride		77
Cyclohexane	3500	105000
Cyclohexanol	2080	62400*
Cyclohexanone	1020	40800
Cyclohexene	10200	306000*
Cyclohexylamine	410	12300*

APPENDIX D
ENVIRONMENTAL BENCHMARKS
Air

Substance	**Long term EAL$^{(note\ a)}$, µg/m^3**	**Short term EAL$^{(note\ b)}$, µg/m^3**
Cyhexatin (ISO)	50	1000
2,4-D (ISO)	100	2000
Dialkyl 79 phthalate	50	1500*
Diallyl phthalate	50	1500*
1,2-Diaminoethane	250	7500*
Diammonium peroxodisulphate (measured as [S2O8])	10	300*
Diazinon (ISO)	1	30
Dibenzoyl peroxide	50	1500*
Dibismuth tritelluride	100	2000
Dibismuth tritelluride, selenium doped	50	1000
Diborane	1.2	36*
Diboron trioxide	100	2000
Dibromodifluoromethane	8720	131000
1,2-Dibromoethane	7.8	234*
Dibutyl hydrogen phosphate	87	1700
Dibutyl phthalate	50	1000
6,6'-Di-tert-butyl-4,4'-thiodi-m-cresol	100	2000
6,6-Di-tert-butyl-4,4-thiodi-m-cresol	100	2000
Dichloroacetylene		39
1,2-Dichlorobenzene		30600
1,4-Dichlorobenzene	1530	30600
Dichlorodifluoromethane	50300	628000
1,3-Dichloro-5,5-dimethyl-hydantoin	2	40
1,1-Dichloroethane	8230	165000
1,2-Dichloroethane	42	700 (e,h)
1,2-Dichloroethylene, cis:trans isomers 60:40	8060	101000
Dichlorofluoromethane	430	12900*
Dichloromethane	700	3000 (e, f)
2,2'-Dichloro-4,4'-methylene dianiline	0.01	0.3*
Dichlorvos (ISO)	9.2	280
Dicyclohexyl phthalate	50	1500*
Dicyclopentadiene	270	8100*
Dieldrin (ISO)	2.5	75
Diethylamine	300	7600
2-Diethylaminoethanol	490	14700*
Diethyl ether	12300	154000
Diethyl phthalate	50	1000
Diisobutyl phthalate	50	1500*
Diisodecyl phthalate	50	1500*
Diisononyl phthalate	50	1500*
Diisooctyl phthalate	50	1500*
Diisopropylamine	210	6300*
Diisopropyl ether	10600	131000
Dimethoxymethane	31600	395000
NN-Dimethylacetamide	360	7200
Dimethylamine	38	1100
NN-Dimethylaniline	250	5000
1,3-Dimethylbutyl acetate	2990	59900
NN-Dimethylethylamine	300	4600
Dimethylformamide	300	6100
2,6-Dimethylheptan-4-one	1480	44400*
Dimethyl phthalate	50	1000
Dimethyl sulphate	0.52	15.6*
Dinitrobenzene, all isomers	10	350
Dinonyl phthalate	50	1500*
1,4-Dioxane	910	36600

Substance	**Long term EAL$^{(note\ a)}$, µg/m^3**	**Short term EAL$^{(note\ b)}$, µg/m^3**
Dioxathion (ISO)	2	60*
Diphenylamine	100	2000
Diphenyl ether vapour	71	2130*
Diphosphorus pentasulphide	10	300
Diphosphorus pentoxide		200
Dipotassium peroxodisulphate (measured as [S2O8])	10	300*
Diquat dibromide (ISO)	5	100
Disodium disulphite	50	1500*
Disodium peroxodisulphate (measured as [S2O8])	10	300*
Disodium tetraborate anhydrous	10	300*
Disodium tetraborate decahydrate	50	1500*
Disodium tetraborate pentahydrate	10	300*
Disulfoton (ISO)	1	30
Disulphur dichloride		560
Disulphur decafluoride	2.6	79
Diuron (ISO)	100	3000*
Divinadium pentaxode (as V)	0.5	15*
Divinylbenzene	540	16200*
Endosulfan (ISO)	1	30
Endrin (ISO)	1	30
2,3-Epoxypropyl isopropyl ether	2410	36200
Ethane-1,2-diol particulate	100	3000*
Ethane-1,2-diol vapour	600	12500
Ethanethiol	13	520
Ethanol	19200	576000*
2-Ethoxyethanol	74	2220*
2-Ethoxyethyl acetate	110	3300*
Ethyl acetate	14600	420000*
Ethyl acrylate	210	6200
Ethylamine	38	1100
Ethylbenzene	4410	55200
Ethyl chloroformate	45	1350*
Ethyl cyanoacrylate		30
Ethylene dinitrate	13	130
Ethylene oxide	18.4	552*
Ethyl formate	3080	46200
2-Ethylhexyl chloroformate	80	2400*
4-Ethylmorpholine	240	9600
Fenchlorphos (ISO)	100	3000*
Ferbam (ISO)	100	2000
Ferrocene	100	2000
Fluoride (as F)	1$^{(j)}$	2.8 $^{(j)}$
Fluorine		160
Formaldehyde	5	100 (e, g)
Formamide	370	5600
Formic acid	96	2880*
2-Furaldehyde	80	2000
Furfuryl alcohol	200	6100
Germane	6.4	190
Glutaraldehyde	0.4	4
Glycerol mist	100	3000*
Glycerol trinitrate	19	190
Hafnium	5	150
Heptan-2-one	2370	47500
Heptan-3-one	2370	47500
Hexachloroethane vapour	490	14700*
Hexachloroethane total inhalable dust	100	3000*
Hexachloroethane respirable dust	40	1200*
Hexahydro-1,3,5-trinitro-1,3,5-triazine	15	300

Substance	Long term EAL$^{(note\ a)}$, µg/m^3	Short term EAL$^{(note\ b)}$, µg/m^3
n-Hexane	720	21600*
1,6-Hexanolactam dust	10	300
1,6-Hexanolactam vapour	230	4700
Hexan-2-one	210	6300*
Hydrazine	0.06	2.6
Hydrogen bromide		1000
Hydrogen chloride	20	800
Hydrogen cyanide		220
Hydrogen fluoride (as F)		250
Hydrogen peroxide	14	280
Hydrogen selenide (as Se)	1.7	51*
Hydrogen sulphide	140	150 (e), (f)
Hydroquinone	20	400
4-Hydroxy-4-methyl-pentan-2-one	2410	36200
2-Hydroxypropyl acrylate	27	810*
2,2'-Iminodiethanol	130	3900*
2,2'-Iminodi(ethylamine)	43	1290*
Indene	480	7200
Indium and compounds (as In)	1	30
Iodine		110
Iodoform	98	1600
Iron salts (as Fe)	10	200
Isobutyl acetate	7240	90300
Isocyanates (as NCO)	0.2	7
Isooctyl alcohol (mixed isomers)	2710	81300*
Isopentyl acetate	2700	54100
Isopropyl acetate		84900
Isopropyl chloroformate	51	1530*
Ketene	8.7	260
Lead	0.5 (c)	
Lindane (hexachlorocyclohexane)	5	150
Lithium hydride	0.25	7.5*
Lithium hydroxide		100
Malathion (ISO)	100	3000*
Manganese and compounds (as Mn)	1 (e), (f)	1500*
Mequinol (INN)	50	1500*
Mercaptoacetic acid	38	1140*
Mercury alkyls (as Hg)	0.1	3
Mercury and compounds, except mercury alkyls, (as Hg)	0.25	7.5*
Methacrylic acid	720	14300
Methacrylonitrile	28	840*
Methanethiol	10	300*
Methanol	2660	33300
Methomyl (ISO)	25	750*
Methoxychlor (ISO)	100	3000*
2-Methoxyethanol	32	960*
2-Methoxyethyl acetate	50	1500*
1-Methoxypropan-2-ol	3750	112000
Methyl acetate	6160	77000
Methyl acrylate	360	10800*
Methylamine	130	3900*
N-Methylaniline	22	660*
3-Methylbutan-1-ol	3660	45800
1-Methylbutyl acetate	2700	54100
methyl-tert-butyl-ether	920	27500
Methylcyclohexanol	2370	35600
2-Methylcyclohexanone	2330	35000
2-Methyl-4,6-dinitrophenol	2	60
4,4'-Methylenedianiline	0.16	4.8*
Methyl ethyl ketone peroxides		150
Methyl formate	2500	37400

Substance	Long term EAL$^{(\text{note a})}$, µg/m^3	Short term EAL$^{(\text{note b})}$, µg/m^3
5-Methylheptan-3-one	1330	39900*
5-Methylhexan-2-one	2370	47500
Methyl methacrylate	2080	41600
2-Methylpentane-2,4-diol	1230	12300
4-Methylpentan-2-ol	1060	17000
4-Methylpentan-2-one	2080	41600
4-Methylpent-3-en-2-one	610	10200
2-Methylpropan-1-ol	1540	23100
2-Methylpropan-2-ol	3080	46200
1-Methyl-2-pyrrolidone	1030	30900
Methylstyrenes, all isomers except a-methylstyrene	4910	73600
N-Methyl-N, 2,4,6-tetranitroaniline	15	300
Mevinphos (ISO)	0.9	28
Molybdenum compounds (as Mo) soluble compounds	50	1000
Molybdenum compounds (as Mo) insoluble	100	2000
Monochloroacetic acid	12	360*
Morpholine	720	10900
Naled (ISO)	30	600
Naphthalene	530	8000
Nickel and inorganic compounds (as Ni)	1	30*
Nickel, organic compounds (as Ni)	10	300
Nicotine	5	150
Nitric acid	52	1000
4-Nitroaniline	60	1800*
Nitrobenzene	51	1000
Nitroethane	3210	93600*
Nitrogen dioxide	40 (c) see table D1	200 (c) see Table D1
Nitrogen monoxide	310	4400
Nitrogen trifluoride	300	4400
Nitromethane	2540	38100
1-Nitropropane	930	27900*
2-Nitropropane	38	1140*
Nitrotoluene, all isomers	290	5700
Octachloronaphthalene	1	30
Orthophosphoric acid		200
Osmium tetraoxide (as Os)	0.02	0.6
Oxalic acid	10	200
Oxalonitrile	220	6600*
2,2'-Oxydiethanol	1010	30300*
Ozone		100
Parathion (ISO)	1	30
Parathion-methyl (ISO)	2	60
Particulates	40 (c) see table D1	50 (c) see table D1
Pentacarbonyliron (as Fe)	0.8	24*
Pentachlorophenol	5	150
Pentan-2-one	7160	89500
Pentan-3-one	7160	89500
Pentyl acetate	2700	54100
Perchloryl fluoride	130	2600
Phenol	200	3900
p-Phenylenediamine	1	30*
Phenyl-2,3-epoxypropyl ether	62	1860*
2-Phenylpropene		49100
Phorate (ISO)	0.5	20
Phosgene	0.8	25
Phosphine		42
Phosphorus, yellow	1	30
Phosphorus pentachloride	8.7	261*
Phosphorus trichloride	11	290

Substance	Long term EAL$^{(note\ a)}$, µg/m^3	Short term EAL$^{(note\ b)}$, µg/m^3
Phosphoryl trichloride	13	380
Phthalic anhydride	8	240
Picloram (ISO)	100	2000
Picric acid	1	30
Piperazine dihydrochloride	50	1500*
Piperidine	35	1050*
Platinum metal	50	1500*
Polychlorinated biphenyls	0.2	6
Potassium hydroxide		200
Propane-1,2-diol vapour & particulates	4740	142200*
Propan-1-ol	5000	62500
Propan-2-ol	9990	125000
Propionic acid	310	4600
Propoxur (ISO)	5	200
n-Propyl acetate	8490	106000
Propylene dinitrate	14	140
Propylene oxide	24	720
Prop-2-yn-1-ol	23	700
Pyrethrins (ISO)	50	1000
Pyridine	160	3300
2-Pyridylamine	20	780
Rhodium (as Rh) metal fume and dust	1	30
Rhodium (as Rh) soluble salts	0.01	0.3
Rotenone (ISO)	50	1000
Selenium and compounds, except hydrogen selenide (as Se)	1	30*
Silane	6.7	130
Silver compounds (as Ag)	0.1	3*
Sodium azide (as NaN3)		30
Sodium 2-(2,4-dichlorophenoxy)ethyl sulphate	100	2000
Sodium fluoroacetate	0.5	15
Sodium hydrogensulphite	50	1500*
Sodium hydroxide		200
Stibine	5.2	160
Strychnine	1.5	45
Styrene	800(i)	800 (e), (f)
Sulfotep (ISO)	2	60*
Sulphur dioxide	50(h)	267
Sulphur hexafluoride	60700	759000
Sulphuric acid	10	300*
Sulphur tetrafluoride	4.5	130
Sulphuryl difluoride	210	4200
2,4,5-T (ISO)	100	2000
TEPP (ISO)	0.5	12
Tantalum	50	1000
Tellurium and compounds, except hydrogen telluride, (as Te)	1	30*
Terphenyls, all isomers		480
1,1,2,2-Tetrabromoethane	72	2160*
Tetracarbonylnickel (as Ni)		24
1,1,1,2-Tetrachloro-2,2-difluoroethane	8470	84700
1,1,2,2-Tetrachloro-1,2-difluoroethane	8470	84700
Tetrachloroethylene	3450	8000$^{(e), (f)}$
Tetrachloronaphthalenes, all isomers	20	400
Tetraethyl orthosilicate	870	26000
Tetrahydrofuran	3000	59900
Tetramethyl orthosilicate	63	3200

Substance	Long term EAL(note a), $\mu g/m^3$	Short term EAL(note b), $\mu g/m^3$
Tetramethyl succinonitrile	28	1100
Tetrasodium pyrophosphate	50	1500*
Thallium, soluble compounds (as Tl)	1	30*
Thionyl chloride		490
Thiram (ISO)	50	1000
Tin compounds, inorganic, except SnH4, (as Sn)	20	400
Tin compounds, organic, except cyhexatin (ISO), (as Sn)	1	20
Titanium dioxide total inhalable dust	100	1000
Titanium dioxide respirable dust	40	400
Toluene	1910	8000(e), (f)
p-Toluenesulphonyl chloride		500
o-Toluidine	1.78	53.4*
Tributyl phosphate, all isomers	50	500
Tricarbonyl(eta-cyclopentadienyl) manganese (as Mn)	1	30
Tricarbonyl(methylcyclopentadienyl) manganese (as Mn)	2	60
1,2,4-Trichlorobenzene	76	2280*
1,1,1-Trichlorobis(chlorophenyl)ethane	10	300
1,1,1-Trichloroethane	11100	222000
Trichloroethylene	1100	1000(e), (f)
Trichlorofluoromethane	57100	714000
Trichloronitromethane	6.8	210
1,2,3-Trichloropropane	3060	46000
1,1,2-Trichlorotrifluoroethane	77900	974000
Triethylamine	420	6300
Trimanganese tetraoxide	10	300*
Trimethylamine	250	3700
Trimethylbenzenes, all isomers or mixtures	1250	37500*
3,5,5-Trimethylcyclohex-2-enone		2900
Trimethyl phosphite	100	3000*
2,4,6-Trinitrotoluene	5	150*
Triphenyl phosphate	30	600
Tri-o-tolyl phosphate	1	30
Tungsten and compounds (as W) soluble	10	300
Tungsten and compounds (as W) insoluble	50	1000
Turpentine	5660	85000
Uranium compounds, natural, soluble, (as U)	2	60
Vanadium	5	1(e, f)
Vinyl acetate	360	7200
Vinyl chloride	159	1851
Vinylidene chloride	80	2400*
Warfarin (ISO)	1	30
Xylene, o-, m-, p- or mixed isomers	4410	66200
Xylidine, all isomers	100	5000
Yttrium	10	300
Zinc chloride	10	200
Zinc oxide	50	1000
Zirconium compounds (as Zr)	50	1000

(a) Unless otherwise stated, derived from Health & Safety Executive, EH40/2001, Occupational Exposure Limits 2001, 8 hour reference period converted to annual mean (see notes on derivation below).

(b) Unless otherwise stated, derived from Health & Safety Executive, EH40/2001, Occupational Exposure Limits 2001, 15 minute reference period converted to hourly mean. Where marked by *, indicates that no short term OEL or MEL is provided in EH40, and the value has been derived by multiplying the long term OEL or MEL by a factor of 30. (see notes on derivation method below).

(c) Source: Expert Panel on Air Quality Standards

(d) Annual mean derived from values for annual reference period (running annual mean)

(e) World Health Organisation WHO, Air quality guidelines 2000

(f) EAL derived from values for 24 hour reference period

(g) EAL derived from values for 30 minute reference period

(h) Source: World Health Organisation WHO Air Quality Guidelines for Europe – Update and Revision. EUR/IGP/EHAZ94.05/PB01, 1995

(i) Short term value from source (e) substitutes the higher Long term value from source (a)

(j) Source: RH Schulze, Trinity Consultants Inc. Practical Guide to Atmospheric Dispersion Modelling 1993 Ambient air quality standards set inGermany (annual average) and the Netherlands (24 hour average)

Derivation of Environmental Assessment levels for Air[8]

For many substances which are released to air EQSs have not been defined. Where the necessary criteria are absent then the Regulators have adopted interim values known as Environmental Assessment Levels (EALs). The EAL is the concentration of a substance which in a particular environmental medium the Regulators regard as a comparator value to enable a comparison to be made between the environmental effects of different substances in that medium and between environmental effects in different media and to enable the summation of those effects.

Ideally EALs to fulfil this objective would be defined for each pollutant:

- based on the sensitivity of particular habitats or receptors (in particular three main types of receptor should be considered, protection of human health, protection of natural ecosystems and protection of specific sensitive receptors, e.g. materials, commercial activities requiring a particular environmental quality;
- be produced according to a standardised protocol to ensure that they are consistent, reproducible and readily understood;
- provide similar measure of protection for different receptors both within and between media;
- take account of habitat specific environmental factors such as pH, nutrient status, bioaccumulation, transfer and transformation processes where necessary.

A suite of EALs derived in this consistent manner is not currently available, therefore, interim values based on published information have been adopted. The table below shows the sources from which information has been obtained. . The table provides an indicative hierarchy of sources, which are listed in order of greatest level of confidence. For consistency, risk based values proposed by the World Health Organisation or given in the IRIS database have been excluded.

Currently some 460 substances or groups of substances are authorised by the Regulators for release to the environment and many of these may be released to air. However, established environmental criteria (other than a limited number of EQSs) are available for only a small fraction of this number. For example, in the case of releases to air, EPAQS have produced guideline values for only six substances (Ozone, Benzene, Carbon Monoxide, Sulphur Dioxide, Particles and 1,3 Butadiene, nitrogen dioxide, PAHs and lead) and the WHO Air Quality Guidelines contain values for 27 substances.

Table D4.1: Sources of information used for setting Environmental Assessment Levels for releases to air

Information source
Expert Panel on Air Quality Standards (EPAQS)
EC Air Quality Directives - limit values and guidelines
World Health Organisation Air Quality Guidelines for Europe (1987, 1995)
Other International Organisations (e.g. United Nations Economic Commission for Europe)
Other National Organisations (e.g. US IRIS data base)
Health and Safety occupational exposure limits.
Expert judgement

Ideally EALs for those substances where there are no existing criteria would be derived direct from toxicological data on the effects of the pollutant on a particular receptor. However, an assessment of this type would be a very substantial undertaking which could only be considered over an extended timescale. One approach to overcoming this problem is to make use of occupational exposure limits which provide an assessment for a specific receptor (i.e. adult human workforce) of the toxicological effects of a pollutant. These values might then be progressively revised as further information and resources allow. Indeed a similar approach to this was followed by the then Factory Inspectorate in 1968 when a large number of occupational standards were adopted from the American Conference of Governmental Industrial Hygienists (HMSO 1968) which have since been progressively revised by the Health and Safety Executive on the basis of new information and UK experience.

---

[8] Note that the Environment Agency has produced a concurrent consultation document on a revised method for the derivation of environment assessment levels.

Occupational exposure limits are intended to set a level of exposure based on 8 hours per day, 5 days per week during a normal employment lifetime below which adverse effects are unlikely to arise for the majority of the working population who may be exposed. Occupational limit values may be derived from either actual data on workers or animal toxicity data, in addition, factors such as the ability to achieve or measure the proposed limit may also be taken into consideration. Consequently, the precise basis on which limit values have been set is difficult to determine and a cautious approach needs to be taken in deriving EALs from occupational exposure limits.

In deriving EALs for long-term exposure from occupational limits two factors need to be taken into consideration, the duration of exposure of the general population compared with the workforce and the sensitivity of the group at risk. The weekly exposure of the local population could be up to 168 hours per week (7*24 hrs) rather than the 40 hours (5*8 hrs) which might be expected for the workforce. Moreover, exposure for the general population may extend to 52 weeks compared with an average working year of 44 weeks. On this basis the minimum safety factor would be 4.96 (i.e. (168/40 * 52/44). In addition, since there may be no recovery period between exposure sessions and exposure could be for a lifetime a further safety factor of 2 could be introduced giving a total safety factor of 10.

It might also be expected that the general population will contain more sensitive individuals, for example, children, the elderly or those with diseases such as asthma, than workers who are typically between the ages of 16 and 65. In the absence of other information a factor of 10 is normally used to allow for differences between the population mean and the response of sensitive individuals (WHO 1994). This is likely to be conservative since, in setting occupational limit values, some allowance will have been made for variation in the sensitivity of the workforce to the pollutant concerned. Combining the safety factors for exposure and sensitivity of the general population gives a long-term air quality standard of 1/100th of the 8-hour occupational exposure limit.

In the UK the Health and Safety Executive distinguish two types of long term occupational exposure limits, occupational exposure standards (OESs) and maximum exposure limits (MELs). MELs are set for chemicals where there is particular concern, for example carcinogens, or doubt over the actual no effect level and for occupational health purposes it is an offence to exceed a MEL. Within the workplace this leads to an emphasis on reducing average levels of exposure of the chemical to ensure that the MEL is not exceeded. In practice this leads to an additional safety margin of up to 5 for chemicals which have MELs over those which have OES values. Effectively, therefore, an additional safety factor of up to 5 is achieved in the workplace by setting an MEL and this factor has been incorporated in determining an EAL for those chemicals listed as having an MEL in HSE Guidance Note EH40/2001 (ref 19). For example a safety factor of 500 (10*10*5) is used to set the long term EAL for such substances. Long-term EALs derived through this approach are shown in Table D4.

Where no short-term environmental criteria have been identified in the literature a similar approach to their derivation from occupational exposure limits can be adopted to that described above for long-term EALs. However, in this instance it would be more appropriate to calculate values based on the short-term exposure limits (STELs) set by HSE. Where STELs are not listed then a value of 3 times the 8 hour time weighted average occupational exposure limit may be used.

Since STELs are by definition appropriate for consideration of short-term impacts there is no need for additional safety factors relating to the duration of exposure as suggested for the derivation of long term EALs. Moreover, as STELs already incorporate a limited safety margin for variation in the sensitivity of the workforce an additional factor of 10 is likely to be adequate to account for the increased sensitivity of the general population (ref 20). However, since many atmospheric dispersion models are only able to produce estimates for time averaging periods in the order of 1 hour it would be convenient for the short term EALS also to be expressed on this basis. Typically ratios between concentrations measured over a 15 minute averaging period and those taken over an hour may be between 1.3 - 2.3 (ref 12). Given this relatively small range and the likely over estimate of the safety factor representing variation in human sensitivity it is proposed to adopt a value of 1/10th of the STEL as the short-term EAL.

Where the substance attracts a maximum exposure limit value then an additional safety factor of 5 can be included on a similar basis to that described for the derivation of long term EALS. The safety factors used in deriving long- and short-term EALs are summarised in the table below. Short-term EALs derived by this approach are given in Table D4.

It is recognised that the safety factors shown in the table below have been derived largely on the basis of experience and that for some substances the “true” EAL derived from a more fundamental study of the toxicological data may be very different. EALs derived in this manner need therefore to be treated with caution and where necessary further work undertaken to assess the implication of any actual or potential breaches. However, some comfort in the use of these safety factors may be gained from the fact that they have been applied in a number of IPC authorisations and therefore have been subjected to considerable public scrutiny.

Environmental Assessment Levels for other substances

Table D4 includes a large number of substances but there will be times when EALs for other substances are needed. In these cases it is suggested that the Operator should discuss the requirement with the site inspector who, if necessary, can obtain appropriate advice.

Critical levels for the assessment of sensitive receptors

There are many areas in the UK which have been designated by a variety of UK and International bodies as being worthy of protection. For example, Sites of Special Scientific Interest (SSSIs), Ramsar Sites and World Heritage Sites. It is likely that these sites will contain species, communities or other receptors which will be sensitive to pollution. In addition, material or industrial/commercial activities may have particular environmental requirements.

The presence, location, size and characteristics of any potentially sensitive receptors within the area of impact (or 'footprint') of the process should be identified by the Operator. Where the site has been designated on the basis of its vegetation then the critical levels for SO_2, NO_x and NH_3 as shown in Table D2 and D3 should be applied as the EAL. Since both sulphur and nitrogen oxides possess statutory EQSs the ambient concentration should first be compared with these higher values to determine whether there may be a breach of the EQS. The critical levels should then be used in the subsequent assessment.

Safety factors for use in deriving long and short term EALs from occupational exposure limits.

	Long term EAL **(as an annual average)**	**Short term EAL** **(as a 1 hour average)**
OES 8 hour time weighted average.	$\frac{OES}{100}$ 1	-
MEL 8 hour time weighted average	$\frac{MEL}{500}$ 2	-
OES STEL 15 minute average(1)	-	$\frac{OES\ STEL}{10}$ 3
MEL STEL 15 minute average(1)	-	$\frac{MEL\ STEL}{50}$ 4

For those substances for which a STEL is not listed a figure of 3 times the 8hr time weighted average may be used.

Table D5: Environmental Quality Standards, Water

EQS or EALs may be revised over time, due to new legislation or new scientific information. The Regulators will update the data in this guidance from time to time, and the Operator should ensure that they use the most up to date of these benchmarks.

Substance	Inland Waters (µg/l as annual mean)	Estuary and coastal waters (µg/l as annual mean)
4-chloro-3-methyl phenol (2)	40	40
2-chlorophenol (2)	50	50
2,4-dichlorophenol (2)	20	20
2,4-D (ester) (2)	1	1
2,4-D (non-ester) (2)	40	40
1,1,1-trichloroethane (2)	100	100
1,1,2-trichloroethane (2)	400	300
Aldrin (3)	0.01	0.01
Arsenic (1)	50 (dissolved)	25 (dissolved)
Atrazine (a) (1)	2	2
Azinphos-methyl (1)	0.01	0.01
Bentazone (2)	500	500
Benzene (2)	30	30
Biphenyl (2)	25	25
Cadmium and its compounds (3)	5 (total soluble & insoluble)	2.5 (coastal) 5 (estuarine) (dissolved Cd)
Carbon tetrachloride (3)	12	12
Chloronitrotoluenes (Total) (2)	10	10
Chloroform (3)	12	12
DDT (all isomers) (3)	0.025	0.025
para-para-DDT (3)	0.01	0.01
Demeton (b) (2)	0.5	0.5
1,2 Dichloroethane (4)	10	10
Dichlorvos (1)	0.001	0.04
Dieldrin (3)	0.01	0.01
Dimethoate (2)	1	1
Endosulphan (Total) (1)	0.003	0.003
Endrin (3)	0.005	0.005
Fenitrothion (1)	0.01	0.01
Hexachlorobenzene (3)	0.03	0.03
Hexachlorobutadiene (3)	0.1	0.1
Hexachlorocyclohexane (3)	0.1	0.1
Isodrin (3)	0.005	0.005
Linuron (2)	2	2
Malathion (1)	0.01	0.02
Mecoprop (2)	20	20
Mercury and its compounds (3)	1 (total soluble & insoluble Hg)	0.3 (coastal) 0.5 (estuarine) (dissolved Hg)
Mevinphos (2)	0.02 (MAC)	No EQS
Naphthalene (2)	10	5
Omethoate (2)	0.01	No EQS
Pentachlorophenol and its compounds (3)	2	2
Perchloroethylene (4)	10	10
Simazine (a) (1)	2	2
Toluene (2)	50	40
Triazophos (2)	0.005	0.005
Tributyl tin (Total) (1)	0.02 (MAC)	0.002 (MAC)
Trichlorobenzene (4)	0.4	0.4
Trichloroethylene (4)	10	10
Trifluralin (1)	0.1	0.1
Triphenyl tin (Total) (1)	0.02 (MAC)	0.008 (MAC)
Xylene (2)	30	30

(1) The Surface Waters (Dangerous Substances)(Classification) Regulations 1997, Statutory Instrument 1997, No. 2560
(2) The Surface Waters (Dangerous Substances)(Classification) Regulations 1998, Statutory Instrument 1998, No. 389
(3) The Surface Waters (Dangerous Substances)(Classification) Regulations 1989, Statutory Instrument 1989, No. 2286
(4) The Surface Waters (Dangerous Substances)(Classification) Regulations 1992, Statutory Instrument 1992, No. 337

(a) The standard for atrazine and simazine relates to the individual chemicals if present alone but for the two substances in total if present together
(b) Relates to sum of oxydemeton-methyl and demeton-S-methyl and demeton-S-methyl sulphone
MAC – Maximum Allowable Concentration

Table D6: Environmental Assessment Levels, Water

EQS or EALs may be revised over time, due to new legislation or new scientific information. The Regulators will update the data in this guidance from time to time, and the Operator should ensure that they use the most up to date of these benchmarks.

Short term EALs are shown in shaded text.

Substance	**Inland Waters**			**Estuary and coastal waters**	**comments/source**
	designated fisheries	**aquatic life**			
	EAL (µg/l)	**hardness (mg/l $CaCO_3$)**	**EAL (µg/l)**	**EAL (µg/l)**	
Aldrin	See EQS Table				
Ammonia (unionised) (as N)	4 (G) 95%ile 21 (M) 95%ile		15 (Proposed)	21 (Proposed)	Seager *et al* (1988)
Ammonium (total) (as N)	31 (G) 95%ile 156 (G) 95%ile [4] 778 (M) 95%ile 778 (M) 95%ile [4]				
Arsenic$^{(3)}$	See EQS Table		50	25	Dissolved. Circular 7/89$^{(2)}$
Atrazine (+ simazine)	See EQS Table (although only the AA is included in that)		2 10 MAC	2 10MAC	Dissolved conc^{ns} & combined with simazine. Proposed. DoE (1991)
Avermectins: -					
Abamectin			0.01 0.03 (MAC)	0.003 0.01 (MAC)	
Doramectin			0.001 0.01 (MAC)	0.001 0.01(MAC)	
Ivermectin			0.0001 0.001 (MAC)	0.001 0.01(MAC)	
Azamethiphos			0.02 0.05	0.02 0.05	DETR 1998
Azinphos methyl	See EQS Table (although only the AA is included in that)		0.01 0.04 MAC	0.01 0.04 MAC	Dissolved conc^{ns}. Proposed. DoE (1991)
Bentazone	See EQS Table				
Benzene	See EQS Table				
Biphenyl	See EQS Table		25	25 (G)	Proposed. Barry *et al* (1994)
BOD$_5$	3000 (G) 95%ile 6000 (G) 95%ile [4]				
Boron			2000	7000	Circular 7/89$^{(2)}$
Bromine			2(TRO) 5(TRO) (MAC)	10(TRO) (MAC)	TRO – Total Residual Oxidant. Agency, 1997
Bromoxynil			100 1000 MAC	100 (G) 1000 (MAC)	Proposed. Murgatroyd *et al* (1994)
Cadmium	See EQS Table				
Carbendazim			0.1 1 (MAC)	0.1 1 (MAC)	DETR, 1998
Carbon tetra-chloride	See EQS Table				

Substance	Inland Waters			Estuary and coastal waters	comments/source
	designated fisheries	aquatic life			
	EAL (µg/l)	hardness (mg/l CaCO$_3$)	EAL (µg/l)	EAL (µg/l)	
Chlorfenvinphos			0.03 0.1 (MAC)	0.03 0.1 (MAC)	Agency, 2000
Chlorine (as HOCl)	5 (M) 95%ile at pH 6		2(TAC) 5(TAC) (MAC	10(TRO) (MAC)	6.8 if measured as Cl$_2$. Higher conc^{n} allowed if pH >6. TAC – Total Available Chlorine TRO – Total Residual Oxidant Agency, 1994
Chloroform	See EQS Table				
4-chloro-3-methyl phenol	See EQS Table				
Chloronitro-toluenes	See EQS Table (although only the AA is included in that)		10 100 MAC	10 (G) 100 (G) MAC	As total of isomers 2,4-, 2,5-, 2,6-, 4,2-, 4,3-. Proposed Jerman *et al* (1992)
2-chlorophenol 3-chlorophenol 4-chlorphenol			50 250 (MAC) (Total and individual mono-chlorophenols)	50 250 (MAC) (Total and individual mono-chlorophenols)	DETR, 1997
Chlorothalonil			0.1 1 (MAC)	0.1 1 (MAC)	DoE, 1995
Chlorotoluron			2 20 (MAC)	2	Agency, 1996
Chlorpropham			10 40 (MAC)	10 40 (MAC)	DoE, 1995
Chromium(3)		0 – 50 50 – 100 100 – 200 >200	5 150 [4] 10 175 [4] 20 200 [4] 50 250 [4]	15	Dissolved conc^{ns} Circular 7/89(2)
Cobalt			3 100 (MAC)	3 100 (MAC)	Dissolved. DETR (1998)
Copper(3)	5 (G) 95%ile 22 (G) 95%ile 40 (G) 95%ile 112 (G) 95%ile	10 50 100 500			Dissolved conc^{ns}
		0 – 50 50 – 100 100 – 250 >250	1 6 10 28	5	Dissolved conc^{ns}. (95%ile values also proposed). Circular 7/89(2)
Coumaphos			0.03 0.1 (MAC)	0.03 0.1 (MAC)	Agency, 2000
Cyanide			1 5 (MAC)	1 5 (MAC)	Free cyanide (HCN and CN^{2-} Agency, 1998
Cyfluthrin			0.001 95%ile	0.001 95%ile	Circular 7/89(2)
Cypermethrin			0.0002 0.002 (MAC)	0.0002 0.002 (MAC)	Agency, 2001
2,4-D (ester)	See EQS Table				
2,4-D (non-ester)	See EQS Table				
DDT (all isomers)	See EQS Table				

APPENDIX D
ENVIRONMENTAL BENCHMARKS
Water

Substance	Inland Waters			Estuary and coastal waters	comments/source
	designated fisheries	aquatic life			
	EAL (µg/l)	hardness (mg/l $CaCO_3$)	EAL (µg/l)	EAL (µg/l)	
Demetons	See EQS Table				
Diazinon			0.03 0.1 (MAC)	0.03	Agency, 2000
Dichlorobenzene			20 200 (MAC)	20 200 (MAC)	Dissolved (Sum of all isomers)
1,2-Di-chloro-ethane	See EQS Table				
Dichloromethane			2000 20000 (MAC)	2000 20000 (MAC)	Agency, 2001
2,4-dichlorophenol	See EQS Table				
Dichlorvos	See EQS Table		0.001	0.04	Proposed. DoE (1991) (also MAC values specific to marine fish farm use.)
Dieldrin	See EQS Table				
Diflubenzuron			0.001 0.015 (MAC	0.001 0.015 (MAC	DETR, 1997
Dissolved oxygen	>9000 (M) 50%ile >7000 (M) 50%ile [4] >9000 (G) 50%ile >8000 (G) 50%ile [4] >7000 (G) 100%ile >5000 (G) 100%ile [4]				
Dimethoate	See EQS Table		1 (Proposed)	1 (Proposed)	Murgatroyd *et al* (1994)
Diuron			2 20 (MAC)	2	Agency, 1996
EDTA			400 4000	400 4000	DETR, 1997
Endosulfan	See EQS Table (although only the AA is included on that)		0.003 0.3 MAC	0.003	Dissolved conc^{ns}. Proposed. DoE (1991)
Endrin	See EQS Table				
Ethyl benzene			20 200 (MAC)	20 200 (MAC)	Agency, 2001
Fenchlorphos			0.03 0.1 (MAC)	0.03 0.1 (MAC)	Agency, 2000
Fenitrothion	See EQS Table (although only the AA is included on that)		0.01 0.25 MAC	0.01 0.25 MAC	Proposed. DoE (1991)
Flucofuron			1 95%ile	1 95%ile	Circular 7/89(2)
Fluoride		<50mg/l	1000 3000 (MAC)	5000 15000 (MAC)	No hardness bandings for saline environment. Agency, 1998
		>50mg/l	5000 15000 (MAC)		
Formaldehyde			5 50 MAC	5 50 MAC	Proposed. Jerman *et al* (1993)
Hexachloro-benzene	See EQS Table				
Hexachloro-butadiene	See EQS Table				
Hexachloro-cyclohexane (all isomers)	See EQS Table				
Hydrogen sulphide			0.25 1 (MAC)	10µg/l	Undissociated, DoE

Substance	Inland Waters			Estuary and coastal waters	comments/source
	designated fisheries	aquatic life			
	EAL (µg/l)	hardness (mg/l $CaCO_3$)	EAL (µg/l)	EAL (µg/l)	
Ioxynil			10 100 MAC	10 (G) 100 (G) MAC	Proposed. Murgatroyd *et al* (1993)
Iron			1000	1000	Dissolved conc^{ns}. Circular 7/89$^{(2)}$
Isodrin	See EQS Table				
Isoproturon			2 20 (MAC)	2	Agency, 1996
Lead$^{(3)}$		0 – 50 50 – 150 >150	4 50 [4] 10 125 [4] 20 250 [4]	25	Dissolved conc^{ns}. Standards halved if breeding trout present. Circular 7/89$^{(2)}$
Linuron	See EQS Table				
Malachite green			0.5 100 MAC		Proposed. Burchmore *et al* (1993)
Malathion	See EQS Table (although only the AA is included on that)		0.01 0.5 MAC	0.02 0.5 MAC	DoE (1991)
Mancozeb			2 20 (MAC)	2 20 (MAC)	DETR, 1997
Maneb			3 30 (MAC)	3 30 (MAC)	DETR, 1997
Mecoprop			20 200 (MAC)	20 200 (MAC)	Agency
Mercury	See EQS Table				
Methiocarb			0.01 0.16 (MAC)	0.01 0.16 (MAC)	DETR, 1997
Methyl phenol			100 300 (MAC)	100 300 (MAC)	Agency, 2001
Mevinphos	See EQS Table				
Naphthalene	See EQS Table		10 100 (MAC)	5 80 (MAC)	Agency, 1997
Nickel$^{(3)}$		0 – 50 50 – 100 100 – 200 >200	50 100 150 200	30	Dissolved conc^{ns}. Circular 7/89$^{(2)}$
Nitrite (as N)	3 (G) 95%ile 9 (G) 95%ile [4]				
Nonyl phenol			1 2.5 (MAC)	1 2.5 (MAC)	Agency, 1998
NTA			1000 10000 (MAC)	3000 30000	DETR, 1997
Octyl phenol			1 2.5 (MAC)	1 2.5 (MAC)	Agency, 1998
Omethoate	See EQS Table				
p-p-DDT	See EQS Table				
PCSDs			0.05 95%ile	0.05 95%ile	Circular 7/89$^{(2)}$
Pendimethalin			1.5 6 (MAC)	1.5 6 (MAC)	DETR, 1997
Pentachloro-phenol & compounds	See EQS Table				
Perchloro-ethylene	See EQS Table				
Permethrin			0.01 95%ile	0.01 95%ile	Circular 7/89$^{(2)}$

APPENDIX D
ENVIRONMENTAL BENCHMARKS
Water

Substance	Inland Waters			Estuary and coastal waters	comments/source
	designated fisheries	aquatic life			
	EAL (µg/l)	hardness (mg/l $CaCO_3$)	EAL (µg/l)	EAL (µg/l)	
pH	>6.0 (M) 95%ile >9.0 (M) 95%ile		>6.0 95%ile >9.0 95%ile	>6.0 95%ile (>7.0 for shellfish) <8.5 95%ile	Also artificial variations should not exceed 0.5 pH units. Circular 7/89(2)
Phenol			30 300 (MAC)	30 300 (MAC)	Agency, 1995
Phosphorus (as P)	65 (G) MAC 130 (G) MAC [4]				Limit values to reduce eutrophication
Phthalates:-					DETR, 1998
Dimethyl phthalate			800 4000 (MAC)	800 4000 (MAC)	
Diethyl phthalate			200 1000 (MAC)	200 1000 (MAC)	
Dibutyl phthalate			8 40 (MAC)	8 40 (MAC)	
Butylbenzyl phthalate			20 100 (MAC)	20 100 (MAC)	
Dioctyl phthalate			20 40 (MAC)	20 40 (MAC)	
Pirmicarb			1 5 (MAC)	1 5 (MAC)	Total, DoE (1996)
Pirimiphos-methyl			0.015 0.05 (MAC)	0.015 0.05 (MAC)	DETR, 1997
Prochloraz			4 40 (MAC)	4 40 (MAC)	DETR, 1998
Propetamphos			0.03 0.1 (MAC)	0.03 0.1 (MAC)	Agency, 2000
Silver			0.05 0.1 (MAC)	0.5 0.1 (MAC)	Dissolved. DoE (1996)
Simazine (+ atrazine)	See EQS Table (although only the AA is included on that)		2 10 MAC	2 10 MAC	Dissolved conc^{ns} and combined with atrazine. DoE (1991)
Sulcofuron			25 95%ile	25 95%ile	Circular 7/89(2)
Styrene			50 500 (MAC)	50 500 (MAC)	Agency, 1995
Suspended solids	25000 (G)				
Tecnazene			1 10 MAC	1 10 MAC	Proposed. Murgatroyd *et al* (1993)
Temperature	δT < 1.5°C (M) 98%ile δT < 3.0°C (M) 98%ile [4] T < 21.5°C (M) 98%ile T < 28.0°C (M) 98%ile [4]				Also T < 10.0°C during breeding season of fish species needing cold water for reproduction (98%ile).
Tin (inorganic)			25	10	Proposed. Mance *et al* (1988)
Toluene	See EQS Table (although only the AA is included on that)		50 500 MAC	40 400 MAC	Proposed. Jones *et al* (1992)
Triallate			0.25 500 (MAC)	0.25 500 (MAC)	Total DETR, 1998
Triazophos			0.005 0.05 (MAC)	0.005 0.05 (MAC)	DoE, 1994
Tributyl phosphate			50 500 (MAC)	50 500 (MAC)	DETR, 1998

Substance	Inland Waters			Estuary and coastal waters	comments/source
	designated fisheries	aquatic life			
	EAL (µg/l)	hardness (mg/l $CaCO_3$)	EAL (µg/l)	EAL (µg/l)	
Tributyl tin	See EQS Table		0.02 MAC	0.002 MAC	Circular 7/89(2)
Trichloro-benzenes (all isomers)	See EQS Table				
1,1,1-Tri-chloroethane	See EQS Table (although only the AA is included on that)		100 1000 MAC	100 (G) 1000 (G) MAC	Proposed. Rees *et al* (1992)
1,1,2-trichloroethane			400 4000 (MAC)	300 3000 (MAC)	DoE (1992)
Trichloroethylene	See EQS Table				
Trifluralin	See EQS Table (although only the AA is included on that)		0.1 dissolved 1 MAC dissolved 20 MAC	0.1 dissolved 20 MAC	Proposed. DoE (1991)
Triphenyl tin	See EQS Table		0.02 MAC	0.008 MAC	Circular 7/89(2)
Vanadium		0 – 200 >200	20 60	100	Circular 7/89(2)
Xylene			30 300 (MAC)	30 300 (MAC)	DETR, 1997
Zinc(3)	30 (M) 95%ile 300 (M) 95%ile [4] 200 (M) 95%ile 700 (M) 95%ile [4] 300 (M) 95%ile 1000 (M) 95%ile [4] 500 (M) 95%ile 2000 (M) 95%ile [4]	10 10 50 50 100 100 500 500			
		0 – 50 50 – 100 100 – 250 >250	8 75 [4] 50 175 [4] 75 250 [4] 125 500 [4]	40 dissolved	(95%ile values also proposed.) Circular 7/89(2)

Notes:

(1) *Directive on the quality of freshwaters needing protection or improvement in order to support freshwater fish life. 18th July 1978 (78/659/EEC). Official Journal **L222**, 14th August, 1978)*

(2) *Department of the Environment and Welsh Office. Water and the Environment Circular 7/89 (Circular 16/89 Welsh Office), 30th March 1989*

(3) *EQS values for these substances are currently under review by the DoE. The EALs presented here are based on EQS values laid down in Circular 7/89(2)*

[4] Refers to less sensitive receptors i.e. Cyprinid

MAC Maximum Allowable Concentration

(G) Guideline value (for those figures in `Designated Fisheries' columns, applies only to those waters designated under the Directive(1))

(M) Mandatory value (for those figures in `Designated Fisheries' columns, applies only to those waters designated under the Directive(1))

APPENDIX D
ENVIRONMENTAL BENCHMARKS
Water

Environmental Quality Standards for water

The definition and purpose of environmental quality standards is discussed earlier with respect to air, however, the same principles can be applied to water. The Framework Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community provides the basis for setting statutory EQSs in the UK. The annex to the Directive identifies two types of substance, List I and List II substances .

List I comprises substances which require particularly stringent control. However, a particular substance is not confirmed as List I until a daughter directive setting Community limit values has been agreed. In England and Wales these limit values have been implemented through the Surface Waters (Dangerous Substances) (Classification) Regulations These regulations establish a classification system for all surface waters in England and Wales and a Direction issued by the Secretary of State requires the appropriate authority to ensure compliance with the specified limit values. Statutory EQSs for releases to water are shown in Table D1.

All substances that belong to those groups detailed under List I but for which limit values and quality standards have not been agreed by the Community are treated as List II substances. For List II substances the Directive requires quality standards to be set at National Level. For the purposes of this assessment methodology UK quality standards for List II substances are considered to be EALs. As with Statutory EQSs for List I substances, these EALs should be considered as upper limits of acceptability, and their application must not lead, either directly or indirectly, to increased pollution.

A number of other regulations setting out classification schemes for surface waters in the UK have also been produced (i.e. The Surface Waters (Classification) Regulations 1989, Statutory Instrument 1989 No 1148 and The Surface Waters (River Ecosystem (Classification) Regulations 1994, Statutory Instrument 1994 No. 1057). However, no directions have yet been issued to implement these regulations and therefore it has been considered inappropriate to base EALs on the values listed within them.

Environmental Assessment Levels for releases to water

The purpose and characteristics of Environmental Assessment Levels (EALs) for releases to water are similar to those described for releases to air as discussed above. Similarly, a consistent suite of EALs derived in this manner are not available and values based on published criteria have been adopted.

Table D6.1 indicates that a variety of information sources are available from which the EALs set out in Table D6 have been derived. In general the EALs are based on the European Directives, UK National Environmental Quality Standards and UK Proposed National EQSs which are undergoing public consultation (via DoE 1991 or published technical documents). As indicated in Table D6, certain other values are also under review and therefore may be subject to revision in the future. Environmental criteria for a range of other substances are being developed but since these values are yet to be agreed by consultation it would be inappropriate to publish them at this stage.

Table D6.1: ***Sources of information used for setting Environmental Assessment levels for releases to water***

Information source
European Directives (other than those implemented through UK Regulations)
UK National Environmental Quality Standards
UK Proposed National Environmental Quality Standards
Relevant National or international organisations (e.g. US EPA, WHO)
Expert judgement

In selecting an EAL from Table D6 the user should first consider the type of receiving water, ie whether it is inland, estuarine or coastal. Estuaries are considered to extend as far upstream as the tidal limit. For some substances EALs are available as annual average concentrations and 95 percentile or maximum admissible (MAC) concentrations. For reasons of consistency, annual average criteria should be used for calculating the Integrated Environmental Index. Where appropriate information on the flow regime and ambient pollutant concentrations in receiving water are available then the 95 percentile and MAC criteria may be used to assess the short-term impact of releases.

Where the receiving water is a designated fishery under the terms of the EC Fisheries Directive (78/659/EEC) then, and only then, the criteria listed in columns 2 and 3 of Table D6 should be applied. Where more than one requirement might be applied to a particular stretch of water, the most stringent should be used.

Environmental Assessment Levels for other substances

Table D6 includes a number of substances but there will be times when EALs for other substances are needed. In these cases it is suggested that the Operator should discuss the requirement with the site inspector who, if necessary, can obtain appropriate advice.

Table D7: Maximum Deposition Rates & Indicative Substances for Investigation

Indicative Substance for investigation	**Soil Quality Criteria**	**Max Rate Deposit^n (mg m^2.d^{-1})**
Arsenic	50 (2)	0.02 (3)
Atrazine		
Barium		
Benzene		
Cadmium	3 (1)	0.009
Carbaryl		
Carbofuran		
Chlorobenzenes (total mono, di, tri, tetra, penta & hexa)		
Chloronaphthalene		
Chlorophenols (total mono, di, tri, tetra and penta)		
Chromium	400 (2)	1.5
Cobalt		
Copper	80 (1)	0.25
Cresols (total)		
Cyanide (free)		
Cyanide (complex) pH≥5 pH<5		
Thiocyanates		
DDD/DDE/DDT (total)		
Dichloromethane		
Drins (total aldrin, dieldrin, endrin, isodrin)		
Ethyl benzene		
Fluoride	500 (2)	2.1
HCH compounds (alpha, beta, delta & gamma isomers)		
Lead	300 (1)	1.1
Maneb		
Mercury	1 (1)	0.004
Molybdenum	4 (2)	0.016
Nickel	50 (1)	0.11
PAHs (total anthracene, benzo(a)anthracene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, phenanthrene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, benzo(ghi)perylene)		
PCBs (total PCBs 28, 52, 101, 118, 138, 153, 180)		
Phenol		
Phthalates (total)		

Indicative Substance for investigation	**Soil Quality Criteria**	**Max Rate Deposit^{n} (mg m^{2}.d^{-1})**
Pyridine		
Selenium	3 (2)	0.012
Styrene		
Toluene		
Trichloroethylene		
Xylene		
Zinc	200 (1)	0.48

Notes:

(1) The Sludge (Use in Agriculture) Regulations. Statutory Instrument No.1263 HMSO London, 1989

(2) Code of Practice for Agricultural Use of Sewage Sludge Department of the Environment, HMSO, London, 1989

(3) Value proposed by MAFF (pers. comm. 1996) to protect consumers against accumulation in agricultural foodstuffs

The maximum deposition rate (MDR) is the quantity of pollutant which can be added to the soil daily over 50 years before the selected soil quality criteria is exceeded. For inorganic compounds the soil quality criteria were corrected for the median ambient soil concentration and no allowance was made for degradation or other removal processes.

APPENDIX E: AIR DISPERSION MODELLING REPORT GUIDELINES

These guidelines are based on the Environment Agency's Air Dispersion Modelling Report Requirements, EAS (see Reference 14). They are presented here as guidance for the suggested structure of a modelling report, where this has been carried out in response to Section 3.3.3 of H1. The guidance lists the elements of a report that are expected to be present in an air dispersion modelling report, but are not prescriptive requirements.

1. Introduction/scope

The report should include general information relating to the assessment, including purpose of the study, description of the site and modelled scenarios. Suggested content is provided below.

1.1 Location map

A map showing the location of the process in relation to nearby features and urban conurbations and indicating the extent of the modelled domain. The map should use National Grid Referencing and indicate terrain contours, e.g. Ordnance Survey Landranger Series (1:50,000 scale).

1.2 Pollutants and air quality guidelines

A list of pollutants modelled. The pollutants under consideration in the assessment should be clearly identified, including chemical specification (e.g. oxides of nitrogen, halogenated compounds). Discussion of relevant air quality standards and objectives appropriate to the modelled pollutants. These will include the relevant standards and objectives contained in Tables D1, D2 and D3 of H1, such as those in the National Air Quality Strategy (NAQS), guidelines from other sources, e.g. World Health Organisation (WHO) and Environmental Assessment Levels.

1.3 Ambient/background levels

For all pollutants under consideration an appropriate value for background concentration should be determined. This may take the form of ambient monitoring data from local authorities or maps of ambient concentration produced by NETCEN, however the source and validity of information used should be justified by the Applicant. Appropriate sources of information are provided in H1, [location to be added following output from "ambient data" project, due September 2001]. Future predictions of ambient levels should be also addressed if appropriate for the assessment.

1.4 Model description

The choice of model used in the assessment should be justified and a description of the chosen air dispersion model given. Information should include model name, type of model (Gaussian, new-generation, etc.), supplier and version of model used. Models must be fit for purpose, based on established science, and be validated and independently reviewed. EAS/2007/1/1 [full reference or how to obtain] contains Agency policy on choice of air dispersion models.

1.5 Emission parameters

The following information, including relevant units should be presented in a table.

Parameter	Units
Stack Location	(grid reference)
Stack height	(m)
Pollutant emission rate	(g/s) [1, 2]
Exit diameter	(m)
Exit temperature	(K, °C)
Efflux velocity (actual), and/or	(m/s)
Volumetric flow rate (actual)	(m^3/s)

1. Note that pollutant emission rate is often calculated using a measured concentration value, or a value taken from an appropriate Process Guidance Note, and the volumetric flow. It should be made clear whether concentration values expressed at STP/NTP have been adjusted appropriately to derive the emission rate used in the model and, if so, the method used.

2. Including details of time-varying emissions if appropriate

1.6 Modelled domain/receptors

- The extent of the modelled domain (i.e. the modelled area), and the resolution of the model receptor grid used should be reported and justified by the Applicant. The assumed height above ground level for the receptors (flagpole height) should be reported if appropriate.
- Details of any discrete receptors used to assess impact at sensitive locations should be reported.

1.7 Meteorology/surface characteristics

- The choice of meteorological data used in the model should be discussed in detail and justified by the Applicant. Information should include the location of the chosen met station in relation to the modelled domain, the number of years included in the assessment, and the source of the data (currently either UK Met Office or Trinity Consultants Inc.). The format of the met data used (either hourly sequential or long-term statistical) should be reported and justified and a windrose presented for purposes of clarity.
- Information relating to the surface characteristics at both the meteorological station and within the modelled domain should be reported. This is usually related to the relevant land-use classification(s) however the values of parameters (e.g. roughness length, albedo, Bowen ratio/Priestly-Taylor parameter) describing the classifications used in the model should also be reported.

1.8 Treatment of terrain

The Applicant should justify the inclusion or not of terrain treatment in the assessment and report the source, format and processing of digital terrain data used in the model.

Treatment of Buildings and site plan

The Applicant should justify the inclusion or not of building treatment in the assessment and report the location and dimensions of all buildings included in the model (i.e. NGR, height, width, rotation). A site plan showing the location and relative orientation of buildings and their dimensions should be included.

1.9 Sensitivity analysis

This should include a discussion and quantification of model sensitivity to meteorological data (e.g. different met sites, inter-annual variation, surface characteristics), emission parameters (stack parameters, pollutant release rate, different plant operating scenarios), receptor grid resolution, and treatment of terrain and buildings. A final quantification of model uncertainty should be reported taking the above into account.

1.10 Special treatments

This should include relevant information on specialised model treatments, for instance short-term (puff) releases, coastal models, fluctuations, photochemistry, wet/dry deposition, flare releases, etc.

1.11 Assessment of impacts

This information should be presented in response to Sections 3.3.3 and 3.3.4 of H1.

- A discussion on the post-processing of relevant percentile values and addition of background concentrations should be provided including conversion factors for different averaging times if appropriate.
- Any assumptions relating to pollutant conversion processes (e.g. NO/NO_2 photochemistry) for different averaging times should be justified.
- Results should be presented in tabular form, indicating total (process plus background) concentration values and locations of maximum air quality impacts and the process contribution to this. The percentage impact upon the relevant air quality standard or objective should also be reported.
- Contour plots should be provided for each air quality objective being assessed. These should indicate pollutant name and modelling scenario, averaging time and appropriate percentile plotted and should clearly indicate areas of exceedance. The same colour scale should be used for all contour plots relating to a particular air quality objective.
- Discussion should address any potential breaches of relevant air quality standards or objectives. This should take into account model uncertainty, assessment of different stack heights and emission characteristics and different process operation scenarios.

1.12 Model input files

Input files for the air dispersion model used in the assessment should be included as an Appendix to the report, usually on computer disk. These should be sufficient that model configuration and the parameter values used to define all source and meteorological inputs to the model can be audited.

1.13 Further information

Further detailed information relating to the above topics is contained in EAS. Guidance on air dispersion modelling of point sources [full reference – or maybe better to say “If further information is required, the Operator should discuss the requirement with the Regulator, who, if necessary can obtain appropriate advice”]. Information is also available direct from AQMAU or on the AQMAU Intranet pages.

2. Checklist.

The following form should be included as a prefix to an air dispersion modelling report:

Item	Ö / ´	Reasons for omission
Location map		
Site plan		
List of pollutants modelled and relevant air quality guidelines		
Details of modelled scenarios		
Details of relevant ambient concentrations used		
Model description and justification		
Special model treatments used		
Table of emission parameters used		
Details of modelled domain and receptors		
Details of meteorological data used (including origin) and justification		
Details of terrain treatment		
Details of building treatment		
Sensitivity analysis		
Assessment of impacts		
Model input files		

APPENDIX F: DIRECT TOXICITY ASSESSMENT

Guidance for incorporating Direct Toxicity Assessments into IPPC Impact Assessments

Aim of this guidance

Section 3.5 of H1 suggests an approach by which Operators can estimate the environmental impacts of releases to water. This is intended to allow the Operator to:

- Demonstrate that the releases are acceptable (do not cause significant pollution),

and

- Enable comparison of impacts for options appraisal of candidate BAT.

Under most circumstances emissions of individual chemicals can be compared with environmental benchmarks referred to as “Environmental Assessment Levels” (‘EALs’). By comparing these non-statutory values with the environmental concentration arising from a process, the possibility of adverse effects on either the natural environment or people may be assessed. H1 describes a tiered approach in which an initial assessment of impact due to emission of a particular chemical is carried out to screen out substances that are released in such small amounts that they are unlikely to have a significant environmental impact. This may be followed by more detailed assessments depending on the magnitude of risk to the environment.

This guidance explains how these assessments of impact of releases to water can benefit from the incorporation of DTA (Direct Toxicity Assessment) techniques alongside or, in some circumstances, instead of the chemical-specific approach based on EALs. Ways in which DTA may be used to assess the environmental impacts associated with different treatment or process options are also described.

Selection of Assessment method

The chemical-specific approach based on EALs is entirely appropriate when we can be confident that the particular chemicals that could have an adverse impact on the environment are being addressed. However, this is not always the case because there are certain limitations to the chemical specific method:

- Some discharges may be highly complex and so there is a very real risk that toxic chemicals whose occurrence and emission characteristics are poorly understood, are not accounted for.
- EALs may not be available for some chemicals, especially the more obscure substances where toxicity data (on which EALs are based) are sparse or absent. In this case, a chemical-specific approach is simply not possible.

DTA can offer some advantages under these circumstances. Essentially, DTA involves the testing of whole samples of (usually liquid) industrial discharges for their effects on aquatic organisms according to well-defined procedures. As a result, information about possible impacts can be gained without the requirement for any knowledge of the chemical composition of the discharge. DTA may therefore be incorporated into the H1 Environmental Assessment and Appraisal of BAT process to:

(a) supplement chemical-specific assessments made under H1, thereby accounting for the effects of substances that might otherwise go undetected, or

(b) provide an alternative to chemical-specific assessment of effects at the detailed level of assessment when there are insufficient ecotoxicological data on the chemical(s) of concern to Permit a chemical-specific assessment. DTA techniques are effective here because they sidestep the need for existing chemical toxicity data.

This distinction is important because it affects how the acceptability of a discharge is assessed and whether further investigation is necessary. In (a) both chemical-specific and DTA data inform the decision about acceptability of a discharge (and hence whether further progression through the H1 process is needed) whilst in (b) a decision about acceptability of the discharge would be based solely on the DTA-based risk assessment.

An additional application can also be recognised, in which DTA techniques are used to assess different process or treatment options. Rather than estimating the chemical releases resulting from different treatment or process options, direct measurements of toxicity are made instead and a judgement about environmental acceptability made on the basis of these results.

Current Guidance on the Direct Toxicity Assessment approach

Regulatory schemes based on DTA are being developed in a number of countries and detailed proposals for applying DTA to liquid discharges are being considered for application in the UK. Detailed Technical Guidance (UK Direct Toxicity Assessment (DTA) Demonstration Programme: Technical Guidance – Addressing Water Quality Problems in Catchments where Acute Toxicity is an Issue, Report No. 00/TX/02/07, UKWIR (2000) (ref 23)) describes the sampling of effluents for testing, conduct of tests, quality aspects of testing, and a framework for making judgements about the acceptability of effluent toxicity. The approach has undergone extensive field evaluation through a

"Demonstration Programme" in 1999-2000. The Technical Guidance also makes provision for the use of high throughput 'screening' tests which can lead to significant savings in the cost of testing compared to the use of full standardised tests. These feature prominently in the proposals for the incorporating DTA into IPPC impact assessments.

At least for the aquatic environment, DTA technology is at an advanced stage and can be applied in a number of Regulatory and non-Regulatory schemes for environmental protection without further refinement. However, it is important to recognise the limitations of the approach. Current Technical Guidance is confined to assessing only the short-term effects of effluent discharges in the aquatic environment. Methods for assessing long-term effects and impacts in other media, e.g. soil, are under development but are unlikely to reach the level of standardisation of the short-term protocols for some time. Moreover, DTA assessments can only be made on "real" samples and so 'desk-based' predictions of toxicity are not an option. The greater reliance on measurement also means that adequate sampling is necessary to account for temporal changes in effluent composition and toxicity.

Selecting suitable discharges

- DTA testing will normally be required for all liquid effluent discharges where IPPC authorisation is sought except where:
- The discharge is not to controlled waters, for example a discharge from an installation to a public sewer would not require DTA.
- The installation is a low impact installation
- The effluent composition is simple

A simple effluent is one where all components have been identified and where the toxicity of the effluent can be explained by the chemical properties of the components.

Because DTA addresses the toxicity of all the chemicals in a sample – including those we do not know about – it is a potentially valuable tool for assessing impacts in circumstances where the Operator is faced with complex discharges and situations where an EAL cannot be derived.

A sector-specific approach might be taken by the Agency in which some sectors are excluded from any formal requirement for DTA testing because there is evidence of little or no effluent toxicity, or discharges to water are chemically well-characterised and hence chemical-specific approaches are thought to be adequate. Reference should be made to the IPPC Sector Guidance Notes for further information although further study, possibly involving a modest programme of sector-specific effluent toxicity screening, may also be necessary.

Even where specific chemicals are known to be present, a lack of existing ecotoxological data may prevent derivation of an EAL. Therefore, DTA may be the only course of action available. In addition, the Operator may opt for a DTA approach even when an EAL is available, e.g. when the EAL is based on only rudimentary data and is therefore subject to large safety factors which may give rise to an over-conservative EAL.

Procedure for DTA Assessment

Overview

DTA testing falls into three stages:

- An Initial Screening Stage
- A Detailed Assessment Stage
- A Toxicity Reduction Stage

The results of each stage will determine whether there is a need to proceed to the next stage. Costs of the initial screening stage are low and the dilution data used in the chemical specific assessment can also be reused. It is preferable that as minimum stage 1 and where necessary stage 2, are completed prior to an application being made.

Initial Screening Stage

This stage consists of

- Assessing the toxicity of the effluent using low cost "high throughput" methods
- Assessing the impact in the receiving environment using basis dilution data

Operators are required to complete basic DTA testing using "high throughput" methods as described in Methods Guidelines for Effluent and Receiving Water Assessment (Environment Agency, 2000).

These provide a rapid result (usually within 24-48h) and the unit costs are substantially lower than standardised tests conforming to international test guidelines. However, it must be appreciated that "high throughput" tests yield only basic information of a substantially lower quality than that obtained from tests performed according to international test guidelines.

Testing is carried out on discharges using at least two aquatic species. For discharges to freshwater, tests based on the water flea *Daphnia magna* and an alga such as *Pseudokirchneriella subcapitata* are recommended. For discharges to saltwater, the recommended test species are an invertebrate (Pacific oyster, *Crassostrea gigas,* or the copepod, *Tisbe battagliai*) and and alga such as *Skeletonema costatum*.

The DTA assessment is confined to short-term procedures in which survival is the most usual test endpoint. The effluent is tested at range of concentrations but including one that approximates to that occurring in the receiving water after it has become fully mixed. Decisions about the acceptability of a discharge's toxicity are based on a comparison of the highest effluent concentration at which no adverse effects are seen in the toxicity tests with the available dilution in the receiving water[9]. Details of the design and interpretation of these tests is to be found in Technical Guidance for the Implementation of Direct Toxicity Assessment (DTA) published by UKWIR in 2001 (Report WRc-NSF/TX02B 217). This report also provides detailed advice on the number of samples that should be taken to account for possible temporal variability in effluent toxicity.

Decisions about the acceptability of discharges are based on the responses of the most sensitive species of those tested. If the screening DTA results show that the effluent has a DTA of 100% i.e. undiluted effluent is not toxic then there is no need to process to the dilution calculation stage, or obviously the next stage of DTA testing.

Dilution in the receiving water is calculated using a similar methodology to the chemical specific assessment. For example for fresh water the chemical specific approach requires that;

3.5.2 Calculate Process Contribution of Substances Released to Rivers

3. **Calculate the process contribution of substances released to inland rivers from:**

$$\mathrm{PC}_{\mathrm{water}} = \frac{(\mathrm{EFR} \times \mathrm{RC})}{(\mathrm{EFR} + \mathrm{RFR})} \times 1000$$

where:

PC = process contribution (µg/l)

EFR = effluent flow rate (m^3/s)

RC = release concentration; concentration of the pollutant in the effluent $^{\text{(note 1)}}$ (mg/l)

RFR = river flow rate (m^3/s).$^{\text{(note 2)}}$

Note: If you already have detailed dispersion/dilution modelling data available that is valid for the activities in the assessment, then this should be used to derive the appropriate process contribution instead of the method above. The Operator should identify where this is the case by inputting the modelled data into the software as prompted.

For DTA purposes the diluted concentration (DC) is calculated using the same equation but without the release concentration RC, i.e.

For Rivers

$$\mathrm{DC} = \frac{(\mathrm{EFR})}{(\mathrm{EFR} + \mathrm{RFR})}$$

For Estuaries

$$\mathrm{DC} = \frac{(\mathrm{EFR})}{\mathrm{DR}}$$

For Coastal Waters

$$DC = \frac{\left(EFR^{2/3}\right)}{DR}$$

In each case reference must be made back to the chemical specific methodology for guidance on units to use.

If more detailed modelling data is available then this data can be used as a replacement for the chemical specific dilution equations approach. As DTA testing is an estimation of acute, short term, toxicity in the receiving environment a conservative value for flowrate should be used, for rivers it is recommended that where data is available the 95th percentile flow be used

The diluted concentration should then be compared with DTA results for the most sensitive species. This can be done by calculating a ratio;

Ratio Diluted Concentration (DC) to toxicity threshold is;

$$\text{Ratio} = \frac{DC}{\text{Toxicity Threshold}}$$

Where the toxicity threshold has been selected for the most sensitive species (for further details refer to the Technical Guidance for the Implementation of Direct Toxicity Assessment (DTA) published by UKWIR 2001 (WRc-NSF/TX02B 217). For example a DTA toxicity threshold might be specified as 1% or 0.01. Where the ratio is less 1 there is no requirement to proceed to the next stage of testing.

For example an effluent has a toxicity threshold of 1.3% (0.013), the discharge flowrate is 0.025m^3/s into a river flowing at 5m^3/s. The diluted concentration (DC) is then 0.005. DTA testing shows that toxicity threshold for the most sensitive species is at a diluted concentration of 1%, or 0.01.

$$\text{Ratio} = \frac{0.005}{0.01}$$

= 0.5.

The results show that the diluted concentration in the receiving environment is less than the toxicity threshold for the most sensitive species. Therefore there is no requirement to proceed to the next stage of testing. If the result had been greater than 1.0 then there would have been a requirement is to proceed to the detailed assessment stage.

Detailed Assessment

If a discharge advances to the detailed tier of assessment, a more thorough evaluation of both effluent toxicity and site-specific dilution is required.

Detailed assessments by DTA require the use of a minimum of three aquatic species, in replicated concentration-response tests performed according to approved “DTA Methods Guidelines” (Environment Agency (2001) Ecotoxicity Test Methods for Effluent and Receiving water Assessment – Comprehensive Guidance). The additional species included at this tier are fish species. The purpose of this step is to generate a greater quantity of ecotoxicity data, which is also more detailed and robust than that generated during tests carried out at lower tiers of evaluation. They are inevitably more expensive to conduct than ‘high throughput’ tests but would only be used in situations where there is evidence of a high risk to the receiving water.

At this level of assessment (the highest within H1), a range of test concentrations is used so that it is possible to assess the extent to which toxicity exceeds the required threshold (i.e. no detectable toxicity after dilution). Reflecting the critical nature of decisions at this level of assessment, it is recommended that ecotoxicity testing should be performed only by accredited facilities, complying with external QC schemes and an internal Quality System. This is consistent with other proposed Regulatory applications of DTA and details of such schemes are to be found in “A Proposed Scheme to Ensure the Quality of Data Generated by Laboratories undertaking Regulatory Ecotoxicological testing: Recommended Procedures for Laboratories Involved in Generating Regulatory Ecotoxicological Data for DTA” (Environment Agency, 1999).

Assess Acceptability

As illustrated above, the ecotoxicity data generated in the detailed assessment are employed in conjunction with dilution data obtained from the parallel dispersion modelling to assess the risk of environmental impact. A "Predicted No-Effect Concentration" (PNEC) is derived, based on the responses of the most sensitive of the array of species tested. Further details about derivation of a PNEC are to be found in Technical Guidance for the Implementation of Direct Toxicity Assessment (DTA) published by UKWIR in 2001 (Report WRc-NSF/TX02B 217). This concentration is then simply compared with the available dilution at the site (based on dilution at a point of protection agreed with the Agency) in question and presented as an environmental quotient (EQ_{DTA}) as follows:

$$\frac{\text{Available dilution (effluent concentration after mixing, \% v/v)}}{\text{PNEC (effluent concentration, \%v/v)}}$$

Unlike the situation with the chemical-specific approach (Section 3.5 in H1), only one EQ is generated for a discharge under the DTA approach.

As this is a detailed assessment the simple dispersion modelling used in the initial assessment can no longer be used and detailed dispersion modelling should be used. The point of protection in the receiving environment should be agreed with local Agency staff. If it is not possible to achieve mutual agreement as to the point of protection then the default is assume dilution is zero and that the point of protection is at the point of effluent discharge.

If adverse impacts are predicted either from a chemical-specific or DTA assessment (i.e. EQ or $EQ_{DTA}>1.0$), it may be necessary to take measures to prevent or reduce significant environmental impact. As noted earlier, in cases where both DTA and chemical-specific assessments have been conducted, the releases may be judged to be unacceptable if either method identifies that this is the case. Using DTA as a tool to investigate options for reducing effluent toxicity is the next stage of DTA. This final stage of DTA testing can be completed as part of the application process or after a permit is issued (subject to the impact of the effluent being acceptable in the short term) as part of the improvement programme.

Toxicity reduction measures

Recommended measures for investigating and reducing toxicity from existing discharges have been described in existing Technical Guidance for DTA. Broadly speaking, two approaches to investigating excessive effluent toxicity are available:

(a) the identification of chemical(s) responsible for effluent toxicity, or

(b) the identification of waste streams and processes that give rise to high toxicity, without necessarily understanding the causes of toxicity.

In both cases, DTA testing plays a prominent role but in different ways. The identification of chemicals responsible for observed toxicity (a) can be investigated through a combination of effluent fractionation coupled with toxicity testing and chemical analysis ("Toxicity Identification Evaluation", TIE) to identify toxic fractions and then further characterisation to identify those substances responsible. Further details are to be found in the previously described Technical Guidance and references contained therein. This approach can lead to a wider range of options (e.g. substitution or reduction of intermediates, diversion or selective treatment of waste streams containing highly toxic chemicals) than might be possible if approach (b) is adopted. However, TIE initiatives can be a significant undertaking for the Operator and success in identifying toxicants cannot always be guaranteed.

In some respects, option (b) ("Toxicity Source Evaluation", TSE) may be more appealing because it does not require such intensive inputs of specialist chemical expertise. Typically, a TSE study involves taking samples of waste streams from different parts of the operation and evaluating their toxicity using the test methods described above. In conjunction with an understanding of the volumes contributed by different processes, those giving rise to particularly high toxic burdens (i.e. toxicity x volume) may be identified. This can help identify treatment or diversion options when such waste streams can be identified but is of less management value when toxic inputs arise from many sources. In this case, a TIE approach may be more useful.

Where several process/treatment options are available, effluent samples from bench- or pilot-scale may be subjected to DTA testing. Where this is possible, this would normally be the preferred first approach and only followed by more intensive investigation (TIE or TSE) if a suitable option cannot be identified.

Further details of toxicity reduction investigations can be found in "UK Direct Toxicity Assessment (DTA) Demonstration Programme, Lower Tees Estuary Project – Part II (UKWIR, 2001)", report Ref. No. 00/TX/02/04, and "UK Direct Toxicity Assessment (DTA) Demonstration Programme, Review of Toxicity reduction Evaluations at Sewage Treatment Works (UKWIR, 2001)", Report Ref. No. 00/TX/02/05.

There are no particular Regulatory requirements for the selection, conduct or interpretation of toxicity tests when they are used to investigate or assess toxicity reduction options. However, “high throughput” tests such as those mentioned in connection with DTA testing earlier have been shown to be highly cost-effective in this role. Advice on the conduct of these tests in a toxicity reduction exercise is to be found in Technical Guidance for the Implementation of Direct Toxicity Assessment (DTA) published by UKWIR in 2001 (Report WRc-NSF/TX02B 217).

Options appraisal

DTA is based on measurement of toxicity and so can only be applied to the evaluation of options that already exist or are at least capable of yielding samples of discharge that can be tested. This may be done using samples taken from bench-scale or pilot-scale production or treatment processes. In this case, an EQ_{DTA} (see above) for each one is derived. From these data, the option that provides an acceptable balance between environmental protection and cost may be identified.

Currently, DTA procedures are available only for discharges to the aquatic medium. Therefore, comparisons on the basis of DTA assessments with emissions to other media are not yet possible. In practice, any comparison with emissions to other media will be based on chemical-specific assessments for those media. However, this comparison is possible using the EQ as a “common currency”. This effectively Permits a comparison of the dilution necessary to reduce toxicity to a level where acute toxicity is zero (DTA) or chemical concentrations are reduced to a level where the EAL is met (chemical-specific approaches).

APPENDIX G: PHOTOCHEMICAL OZONE CREATION POTENTIAL

POCP values calculated relative to ethylene

Hydrocarbon	Photochemical ozone creation potential
alkanes	
methane	0.6
ethane	12.3
propane	17.6
n-butane	35.2
i-butane	30.7
n-pentane	39.5
i-pentane	40.5
Neopentane	17.3
n-hexane	48.2
2-methylpentane	42.0
3-methylpentane	47.9
2,2-dimethylbutane	24.1
2,3-dimethylbutane	54.1
n-heptane	49.4
2-methylhexane	41.1
3-methylhexane	36.4
n-octane	45.3
n-nonane	41.4
2-methyloctane	70.6[1]
n-decane	38.4
2-methylnonane	65.7[1]
n-undecane	38.4
n-dodecane	35.7
cyclohexane	29.0
cyclohexanone	29.9
cyclohexanol	51.8[2]
alkenes	
ethylene	100
propylene	112.3
but -1- ene	107.9
cis -but -2 - ene	114.6
trans - but - 2 - ene	113.2
methylpropene	62.7
cis - pent - 2 - ene	112.1
trans - pent - 2 - ene	111.7
pent - 1 - ene	97.7

APPENDIX G
PHOTOCHEMICAL OZONE CREATION POTENTIAL

Hydrocarbon	Photochemical ozone creation potential
2-methylbut-1-ene	77.1
3-methylbut-1-ene	67.1
2-methylbut-2-ene	84.2
hex - 1- ene	87.4
cis - hex -2- ene	106.9
trans - hex -2- ene	107.3
styrene	14.2
1,3 butadiene	85.1
isoprene	109.2
alkynes	
acetylene	8.5
aromatics	
benzene	21.8
toluene	63.7
o-xylene	105.3
m-xylene	110.8
p-xylene	101.0
ethylbenzene	73.0
n-propylbenzene	63.6
i-propylbenzene	50.0
1,2,3-trimethylbenzene	126.7
1,2,4-trimethylbenzene	127.8
1,3,5-trimethylbenzene	138.1
o-ethyltoluene	89.8
m-ethyltoluene	101.9
p-ethyltoluene	90.6
3,5-dimethylethylbenzene	132.0
3,5-diethyltoluene	129.5
aldehydes	
formaldehyde	51.9
acetaldehyde	64.1
propionaldehyde	79.8
butyraldehyde	79.5
i-butyraldehyde	51.4
pentanaldehyde	76.5
benzaldehyde	- 9.2
ketones	
acetone	9.4
methylethylketone	37.3
methyl-*i*-butylketone	49.0

Hydrocarbon	Photochemical ozone creation potential
methylpropylketone	54.8
diethylketone	41.4
methyl - i - propylketone	36.4
hexan -2- one	57.2
hexan -3- one	59.9
methyl -t- butylketone	32.3
alcohols	
methanol	14.0[2]
ethanol	39.9[2]
1-propanol	56.1[2]
2-propanol	18.8[2]
1-butanol	62.0[2]
2-butanol	44.7[2]
2-methyl-1-propanol	36.0[2]
2-methyl-2-propanol	10.6[2]
3-pentanol	59.5[2]
2-methyl-1-butanol	48.9[2]
3-methyl-1-butanol	43.3[2]
2-methyl-2-butanol	22.8[2]
3-methyl-2-butanol	40.6[2]
diacetone alcohol	26.2
4-hydroxy-4-methyl-2-pentanone	30.7[2]
diols	
ethane-1,2-diol	37.3[2]
propane-1,2-diol	45.7[2]
ethers	
dimethyl ether	18.9[2]
diethyl ether	44.5[2]
methyl-*t*-butyl-ether	17.5[2]
Di-*i*-propyl ether	39.8[2]
ethyl-*t*-butyl ether	24.2[2]
glycol ethers	
2-methoxy ethanol	30.7[2]
2-ethoxy ethanol	38.6[2]
1-methoxy-2-propanol	35.5[2]
2-butoxy ethanol	48.3[2]
1-butoxy-2-propanol	46.3[2]
esters	
methyl formate	2.7[2]
methyl acetate	5.9[2]

APPENDIX G
PHOTOCHEMICAL OZONE CREATION POTENTIAL

Hydrocarbon	Photochemical ozone creation potential
ethyl acetate	20.9[2]
n-propyl acetate	28.2[2]
i-propyl acetate	21.1[2]
n-butyl acetate	26.9[2]
s-butyl acetate	27.5[2]
t-butyl acetate	5.3[2]
organic acids	
formic acids	3.2
acetic acid	9.7
propionic acid	15.0
new oxygenates	
dimethoxy methane	16.4[2]
dimethyl carbonate	2.5[2]
halocarbons	
chloromethane	0.5
methylene chloride	6.8
chloroform	1.7
methylchloroform	0.9
tetrachloroethylene	2.9
trichloroethylene	32.5
vinyl chloride	27.2[1]
1,1-dichloroethane	23.2[1]
cis -dichloroethylene	44.7
trans -dichloroethylene	39.2
other pollutants	
nitric oxide	-42.7
nitrogen dioxide	2.8
sulphur dioxide	4.8
carbon monoxide	2.7

Values of POCP are sourced from Derwent et al (ref 26), except for [1] Derwent et al (ref 27) and [2] Jenkin and Hayman (ref 28).

APPENDIX H: GLOBAL WARMING POTENTIAL

Net Global Warming Potentials relative to CO_2 over 100 years. (Typical uncertainty ^{3} 35% relative to CO_2, Source: IPCC 1996)

Substance	**Chemical formula**	**Atmospheric lifetime (yrs)**	**Global warming potential (GWP)**
Carbon dioxide	CO_2	variable	1
Methane	CH_4	12.3	21
Nitrous oxide	N_2O	120	310
Others			
HFC-23	CHF_3	264	11700
HFC-32	CH_2F_2	5.6	650
HFC-41	CH_3F	3.7	150
HFC-43-10mee	$C_4H_2F_{10}$	17.1	1300
HFC-125	C_2HF_5	32.6	2800
HFC-134	$C_2H_2F_4$	10.6	1200
HFC-134a	CH_2FCF_3	14.6	1300
HFC-152a	$C_2H_4F_2$	1.5	140
HFC-143	$C_2H_3F_3$	3.8	300
HFC-143a	$C_2H_3F_3$	48.3	3800
HFC-227ea	C_3HF_7	36.5	2900
HFC-236fa	$C_3H_2F_6$	209	6300
HFC-245ca	$C_3H_3F_5$	6.6	560
Chloroform	$CHCl_3$	0.51	4
Methylene chloride	CH_2Cl_2	0.46	9
Sulphur hexafluoride	SF_6	3200	23900
Perfluoromethane	CF_4	50000	6500
Perfluoroethane	C_2F_6	10000	9200
Perfluorocyclo-butane	$C\text{-}C_4F_8$	3200	8700
Perfluoropentane	C_5F_{12}	4100	7500
Perfluorohexane	C_6F_{14}	3200	7400

APPENDIX H
GLOBAL WARMING POTENTIAL

Direct Global Warming Potentials relative to CO_2 over 100 years. (Typical uncertainty ?35% relative to CO_2, Source: IPCC 1994)

Substance	**Chemical formula**	**Atmospheric lifetime (yrs)**	**Global warming potential (GWP)**
Carbon tetrachloride	CCl_4	42	1400
Methyl chloroform	CH_3CCl_3	5.40.6	110
CFCs			
CFC-11	$CFCl_3$	50+/-5	4000
CFC-12	CF_2Cl_3	102	85000
CFC-13	$CClF_3$	640	11700
CFC-113	$C_2F_3Cl_3$	85	5000
CFC-114	$C_2F_4Cl_2$	300	9300
CFC-115	C_2F_5Cl	1700	9300
HCFCs			
HCFFC-22	CF_2HCl	13.3	1700
HCFC-123	$C_2F_3HCl_2$	1.4	93
HCFC-124	C_2F_4HCl	5.9	480
HCFC-141b	$C_2FH_3Cl_2$	9.4	630
HCFC-142b	$C_2F_2H_3Cl$	19.5	2000
HCFC-225ca	$C_3F_5HCl_2$	2.5	170
HCFC-225cb	$C_3F_5Cl_2$	6.6	530
Bromocarbons			
H-1301	CF_3Br	65	5600

For Carbon Dioxide released from the conversion of renewable sources, a factor of zero should be assigned.

Renewable non-fossil energy sources include biomass, landfill gas, sewage treatment plant gas and biogas. Biomass means the biodegradeable fraction of products, waste and residues from agriculture (including vegetable and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste.

APPENDIX I: USER INSTRUCTIONS FOR THE H1 SOFTWARE TOOL

General instructions

Save	The software will always automatically save your changes as you switch between the input screens. To make a copy of the H1 software tool and save it under a different name you need to copy and paste the H1 software tool within Windows Explorer.
Print preview	You can preview any page before printing it off. To preview a page select print preview from the File menu on the menu bar.
Print	You can print a selection of pages by clicking on the print button on the menu bar or selecting print from the File menu. This will automatically print off the page that currently appears on your screen.

Working with the database

Help	Click on the yellow '?' button in the menu bar next to the print button. This will bring up a help window, which you can move to a convenient position on the screen, by clicking and dragging. It is advised to keep the help window open while working through the edit screens of the software. The Help window includes two tabs, one for help specific to the page you are currently working on and the other for help specific to the edit box your cursor is currently placed in. The help messages will update automatically as you tab through the various input boxes and change input screen. You can close the help window at any time by clicking on the cross in the top right hand corner of the help window.
Edit screens	Generally each edit screen will display the following: 1. Header bar → Title of edit screen followed, where applicable, by the name of the option and release point currently selected; 2. General menu bar → includes print feature in the File menu; 3. H1 software tool menu bar → includes print button, help button, navigator buttons to switch between edit screens, "Go to" drop-down menu, where applicable "Option" drop-down menu and "Release point" drop-down menu; 4. Edit screen header row, displaying module number and title; 5. Basic edit screen-specific input instructions; 6. Row displaying the titles for the edit boxes; 7. Row displaying units for the edit boxes; 8. Row displaying data examples for the edit boxes; 9. Edit boxes; 10. Where applicable "Add" / "Delete" buttons to add or delete inventory lines; 11. Where applicable comments box.
Entering data	When you are entering data into the H1 software tool, it is advised to use the tab key on your keyboard to jump between data edit boxes. By hitting the shift and the tab key on your keyboard simultaneously you can jump backwards in the edit boxes. Alternatively you can use your mouse pointer to place the cursor in the required edit box.
Go to	A quick way to jump between input screens is to select the required input screen from the "Go to" drop down menu, which is displayed in the menu bar of each input page.
Options and release points	The very top header bar on your edit screen will always indicate to you which option / release point you are currently entering data for. If applicable, you can select between different options and release points from the drop down menus displayed to the right of the "Go to" drop down menu
Adding and deleting inventory lines	When you first visit an edit screen, generally no inventory lines will display. You can add or delete an inventory line by clicking on the "Add" / "Delete" buttons displayed in the bottom left hand corner of the edit screen.
Units	Always ensure that you enter your data in the correct units, i.e. the units displayed above the edit boxes.