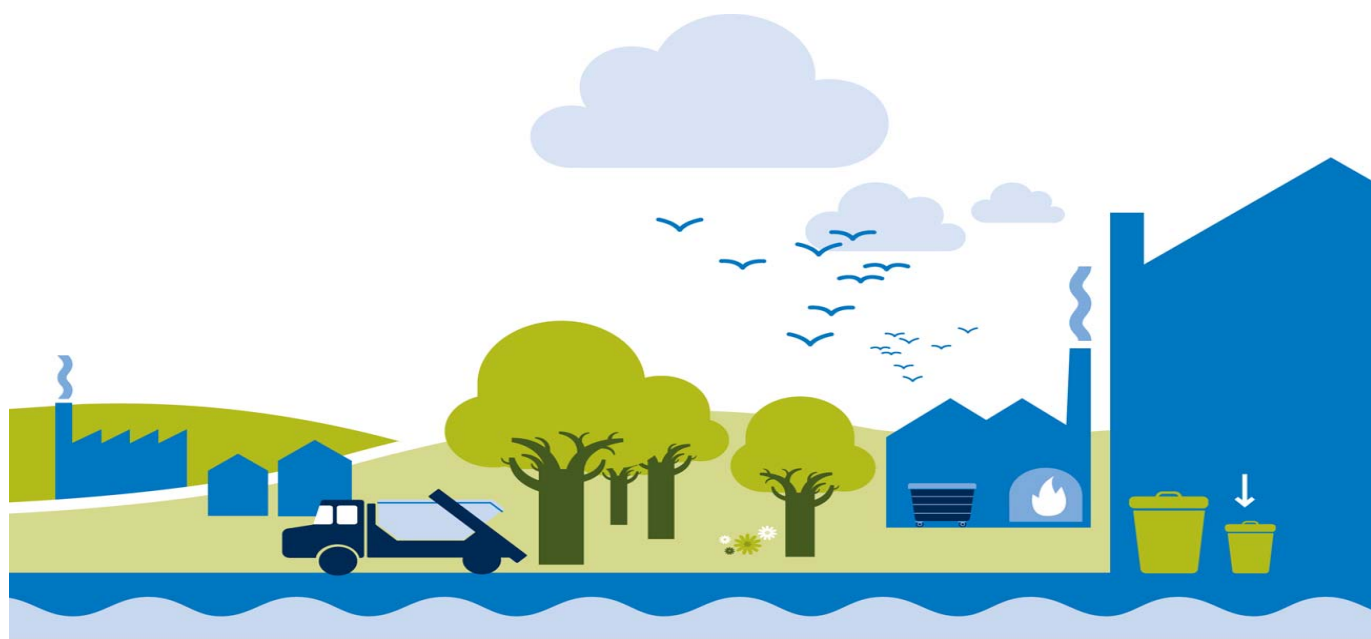


How to comply with your environmental permit
Additional guidance for:

The Production of Large Volume Organic Chemicals (EPR 4.01)



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Introduction

Introduction

In *“Getting the basics right – how to comply with your environmental permit”* (GTBR) we described the standards and measures that we expect businesses to take in order to control the risk of pollution from the most frequent situations in the waste management and process industries.

This sector guidance note (SGN) is one of a series of additional guidance for Part A(1) activities listed in Schedule 1 of the Environmental Permitting Regulations (the Regulations). We expect you to use the standards and measures in this note **in addition** to those in GTBR to meet the objectives in your permit.

Sometimes, particularly difficult issues arise such as problems with odour or noise. You may then need to consult the “horizontal” guidance that gives in depth information on particular topics. Annex 1 of GTBR lists these.

The IPPC Directive requires that the Best Available Techniques (BAT) are used. When making an application, explain how you will comply with each of the indicative BATs in this sector guidance note. Where indicative BAT is not included, where you propose to use an alternative measure or where there is a choice of options you should explain your choice on the basis of

costs and benefits. Part 2 of Horizontal Guidance Note H1 Environmental Risk Assessment (see GTBR Annex 1) gives a formal method of assessing options which you should use where major decisions are to be made.

We will consider the relevance and relative importance of the information to the installation concerned when making technical judgments about the installation and when setting conditions in the permit.

Modern permits describe the objectives (or outcomes) that we want you to achieve. They do not normally tell you how to achieve them. They give you a degree of flexibility.

Where a condition requires you to take appropriate measures to secure a particular objective, we will expect you to use, at least, the measures described which are appropriate for meeting the objective. You may have described the measures you propose in your application or in a relevant management plan but further measures will be necessary if the objectives are not met.

The measures set out in this note may not all be appropriate for a particular circumstance and you may implement equivalent measures that achieve the

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same objective. In cases where the measures are mandatory this is stated.

In response to the application form question on Operating Techniques, you should address each of the measures described as indicative BAT in this note as well as the key issues identified in GTBR.

Unless otherwise specified, the measures and benchmarks described in this note reflect those of the previous Sector Guidance Note. They will be reviewed in the light of future BREF note revisions. In the meantime we will take account of advances in BAT when considering any changes to your process.

Installations covered

This note applies to activities regulated under the following section of schedule 1 of the Regulations:

Section 4.1 - Organic Chemicals
Part A(1)

a) Producing organic chemicals such as:

- (i) hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic)
- (ii) organic compounds containing oxygen, such as alcohols, aldehydes, ketones, carboxylic

acids, esters, ethers, peroxides, phenols, epoxy resins

(iii) organic compounds containing sulphur, such as sulphides, mercaptans, sulphonic acids, sulphonates, sulphates and sulphones and sulphur heterocyclics

(iv) organic compounds containing nitrogen, such as amines, amides, nitrous, nitro- or azo-compounds, nitrates, nitriles, nitrogen heterocyclics, cyanates, isocyanates, di-isocyanates and di-isocyanate prepolymers

(vi) organic compounds containing halogens, such as halocarbons, halogenated aromatic compounds and acid halides

(viii) plastic materials, such as polymers, synthetic fibres and cellulose-based fibres

(ix) synthetic rubbers.

These chemical manufacturing processes include a wide range of different processes with some common features. They are often related to a petroleum refinery, from which they may receive raw materials and utilities and may return by-products and wastes.

Directly associated activities

As well as the main activities described above, the installation will also include directly associated activities which have a direct technical connection with the main activities and which may have an effect on

Introduction

emissions and pollution. These may involve activities such as:

- storage and handling of raw materials
- storage and dispatch of finished products, waste and other materials
- control and abatement systems for emissions to all media
- waste treatment or recycling
- combustion plant
- air separation plant

The impact of the installation's activities on the wider environment may be more extensive than immediately around the on-site operations. This note, in line with the requirements of the Regulations, covers issues downstream of the installation such as the final disposal of wastes and wastewater.

Key issues

The key issues are:

Design of plant and processes

You should optimise processes and techniques at the design stage as this will reduce the potential for emissions and reduce the need for abatement plant to be retrofitted. For example:

- minimising the number of connections in pipework will reduce the opportunity for leaks and fugitive emissions
- care should be taken when selecting construction materials, since severe corrosion can be encountered in some situations

- noise and vibration from furnaces and combustion equipment can be moderated at the design stage
- careful design of building layout taking into consideration the proximity of neighbours can sometimes avoid problems
- site drainage should be designed so that spillages of chemicals, lubricants, etc., are routed to the effluent system, with provision to contain surges and storm-water flows
- good design of flares tips can reduce the need for high rates of steam injection and provide a quieter operation
- the choice and design of cooling systems can have a significant effect on the release of uncondensed VOCs. An increase of a few degrees in condensation temperature may result in a multiple increase in VOC emissions.

There are many other examples.

Point source emissions to air

Many processes release dust, fume or wet particulates, some of which may contain toxic substances such as heavy metal compounds. Some processes release acid gases, ammonia or volatile inorganic or organic compounds.

Releases from point sources should be individually characterised, including those

Introduction

from process and storage vessels as well as those from abatement systems.

Fugitive VOC emissions to air

Installations have large numbers of plant items, flanges, pumps and valves, storage tanks, tanker connections, sample points, etc. which have the potential for leakage of VOCs. This can occur through relaxation or progressive wear-and-tear of sealing materials, through poor operation, maintenance or design, or through failure of equipment. Apart from releases of material through accidental mal-operation or equipment failure, fugitive losses from individual pieces of equipment are usually small, but the aggregated total can be significant.

Waste minimisation and waste disposal routes

Reaction specificity, kinetics, yield, etc are major factors in the generation of waste. For many syntheses the ratio of waste to product is high - so the key issue is to avoid waste generation in the first place by optimizing the reaction arrangements.

Some parts of the sector generate significant quantities of waste that are non-combustible, so there are major disposals to landfill. The Landfill Directive reduces the options for disposal of many chemical waste streams. You must minimise waste as far as possible, always re-using and recycling in preference to disposal.

Point source emissions to water

Producing effluent streams containing complex pollutants such as mixed soluble and insoluble organics, chlorinated hydrocarbons, heavy metals, or non-biodegradable compounds should be avoided where possible. Where this is not practicable these waste water streams need to be minimized and then segregated and treated separately before being discharged to communal effluent treatment facilities.

Energy efficiency

Many installations use large amounts of energy, and the release to air of combustion products is often the biggest single environmental impact by the installation. Most installations will be participants to a Climate Change Agreement or a Direct Participant Agreement but even at these installations there may be some issues which need to be addressed in the permitting process.

Odour

Many of the substances produced or used have the odour potential to cause offence to neighbouring communities. Odours arise from handling inherently malodorous substances and also from fugitive releases of organic solvents. This is a major concern for some installations.

Introduction

Chemical analysis and monitoring of emissions

To improve consistency and comparability of reporting it is imperative that consistency is applied to the streams and substances that are monitored and to the methods of analysis used.

Accident prevention and control

Whilst major accident hazards and associated environmental risks are likely to be covered by the requirements of the COMAH Regulations, you should demonstrate that you have lesser risks well controlled. Loss of containment of liquids that have contaminated land, groundwater and surface water are particular issues in this sector.

1

Managing your activities

- 1.1 Environmental performance indicators**
- 1.2 Accident management**
- 1.3 Energy efficiency**
- 1.4 Efficient use of raw materials and water**
- 1.5 Avoidance, recovery and disposal of wastes**

Environmental performance indicators

Accident management

Energy efficiency

1. Managing your activities

1.1 Environmental performance indicators

Indicative BAT

You should where appropriate:

1. Monitor and benchmark your environmental performance, and review this at least once a year. Your plans for minimising environmental impacts should be incorporated into on-going Improvement Programmes. Indicators can be derived using the Horizontal Guidance Note H1 Environmental Risk Assessment (see GTBR Annex 1). It is suggested that indicators are based on tonnes of organics produced (tOP) as they provide a good basis for measuring performance within an installation or a single company year on year.

1.2 Accident management

In addition to the guidance in *Getting the Basics Right*, guidance prepared in support of the COMAH Regulations may help you in considering ways to reduce the risks and consequences of accidents,

whether or not they are covered by the COMAH regime.

Guidance is available on the Health and Safety Executive website as well as the Environment Agency website.

1.3 Energy efficiency

Some large processes are major users of heat and power and others produce energy from their exothermic reactions. For these there may be greater opportunities for optimising energy efficiency in comparison to the smaller installations in the sector and to many other industrial sectors.

The integrated sites have the greatest scope for energy integration in the sector

but there is a practical limit to the complexity of highly integrated systems which can be effectively operated.

Knock-on difficulties can occur during sequential start up and during major upsets so the absolute maximum of process integration may not always produce the best environmental performance in practice.

Energy Efficiency

Efficient Use of Raw Materials and Water

Indicative BAT

You should where appropriate:

1. Assess the environmental impact of each process and choose the one with the lowest environmental impact. (However, we recognise that your choice may be constrained, for example, by the integration of processes on a complex site).

1.4 Efficient use of raw materials and water

As a general principle, you need to demonstrate the measures you take to:

- reduce your use of all raw materials and intermediates
- substitute less harmful materials, or those which can be more readily abated and when abated lead to substances that are more readily dealt with
- understand the fate of by-products and contaminants and their environmental impact.

In the chemical sectors raw material selection is usually fixed by the chemistry and chemical engineering design of the process. There may be several different processes that can be used to manufacture a particular product but these may differ in product yield, in the wastes that they generate and in the potential for environmental harm of their raw materials.

The purity of raw materials will often affect yields and the presence of impurities may result in the need for excessive recycle and/or recovery operations with

consequent higher energy consumption. The use of high purity raw materials will generally minimise the environmental impact of that process but may have other adverse consequences, e.g. the use of oxygen rather than air may have benefits in reduced emissions to air but these have to be weighed against the energy requirements for air separation, as well as any cost implications.

Water is used widely for cooling, for process use and for cleaning.

A recirculating system with indirect heat exchangers and a cooling tower is preferable to a once-through system for cooling purposes. This avoids most of the heat transfer to the aquatic environment and reduces the risk of undetected contamination. It is also likely to reduce the quantity of treatment chemicals needed. However, you are likely to need a water make-up treatment plant and there will be a concentrated purge stream from the system. You can sometimes use air cooling in place of water but the fans needed use energy and may be noisy.

Efficient use of raw materials and water

Avoidance, recovery and disposal of wastes

Water may be used in direct contact with process materials for either scrubbing or quench cooling. In most cases you can recirculate the water after stripping out the absorbed substances. You will normally need a purge stream to avoid the build-up of contaminants and to remove water that is produced in the process. This will need treatment before discharge (although in

some cases it may be used in another process).

Water used for cleaning can be reduced by a number of techniques, e.g. by using dry methods where possible and spray cleaning rather than whole vessel filling. Water should be reused wherever possible and a hierarchy of sources and opportunities for reuse may be established using pinch analysis.

Indicative BAT

You should where appropriate:

1. Maximise heat transfer between process streams where water is needed for cooling. Use a recirculating system with indirect heat exchangers and a cooling tower in preference to a once-through cooling system.
2. Where water is used in direct contact with process materials, recirculate the water after stripping out the absorbed substances.
3. Use cleaning techniques that reduce the quantity of water needed.
4. Establish opportunities for reuse using pinch analysis.

1.5 Avoidance, recovery and disposal of wastes

Waste should be recovered unless it is technically or economically impractical to do so.

You should list in detail the nature and source of the waste from each activity as the response to the emissions inventory

requirement of the Application. Where there are a very large number of relatively small streams it may be appropriate to aggregate similar and comparatively insignificant waste streams.

Avoidance, recovery and disposal of wastes

Indicative BAT

You should where appropriate:

1. Demonstrate that the chosen routes for recovery or disposal represent the best environmental option. Consider avenues for recycling back into the process or reworking for another process wherever possible.
2. Where you cannot avoid disposing of waste, provide a detailed assessment identifying the best environmental options for waste disposal.

2

Operations

- 2.1 Design of a new process**
- 2.2 Storage and handling of raw materials, products and wastes**
- 2.3 Plant systems and equipment**
- 2.4 Reaction stage**
- 2.5 Separation stage**
- 2.6 Purification stage**
- 2.7 Chemical process controls**
- 2.8 Analysis**

Design of a new process

2. Operations

Introduction

Suitable techniques to prevent pollution and to minimize it at source are discussed under the following headings:

- design of a new process
- storage and handling of raw materials, products and wastes
- plant systems and equipment
- reaction stage
- separation and isolation

- purification and/or final product preparation
- chemical process controls
- analysis

It is not possible to include all techniques which could be classed as “clean technology” because the sector is so diverse.

2.1 Design of a new process

During new project development, environmental issues should be an integral part of discussion at every stage of the design, beginning with the initial concepts. At the initial stage of the development of the process there should be a formal and comprehensive study - the first stage in a formal HAZOP study - of the likely environmental consequences from:

- the use of all raw materials, and production of all intermediates and products
- all routine emissions, discharges and solid/liquid waste streams and
- non-routine or unplanned releases and disposals from, for example:
 - start-ups and shutdowns
 - off-specification products
 - spillages and
 - pressure relief.

You should plan to measure, control and record the quantity and quality of every emission, discharge and waste stream from the process. This includes releases generated from non-routine cleaning or maintenance operations.

You should consider all realistic options for minimising pollution from the outset, and where end-of-pipe techniques are proposed, the costs of abatement, waste treatment and waste disposal should be formally compared with alternatives for waste minimisation at source.

The whole study should use formal HAZOP techniques, and the quality and effectiveness of the study will depend upon the calibre and the commitment of the members of the team involved - which should include process engineers, design engineers, operational staff (including

Design of a new process

those who operate shared facilities like waste-water treatment plants, etc) and it is vital that environmental specialists are also members of the team.

A key purpose of the first part of the HAZOP study is the production of a preliminary environmental statement for the proposed operation, and this should cover the following points:

- Identification and characterisation. This should identify all potential releases.
 - Segregation of all releases. This allows measurement and diagnosis; it also retains the flexibility to pursue recovery, recycling and other waste minimisation opportunities.
 - Treatment of waste streams at source. Most segregated waste streams are more concentrated, of lower volume, and less complex mixtures than combined flows so separate treatment should be considered.
 - Containment of spills. It is important to ensure that all potential spillages are contained, the potential for recovery considered and, where this is not feasible, suitable disposal routes developed.
- Fugitive emissions. Specification of equipment should take into account the likelihood of fugitive emissions, and the positions of piping and of vessels should allow rapid detection and rectification of leaks.
 - Provision for effluent flow equalisation and for emergency discharges. If effluent treatment is on-site the installation must be capable of dealing with fluctuations in flow, composition and concentration, which usually means the provision of holding and balancing tanks.
 - Emergency effluent storage may be required to cope with unusual events such as fire-fighting water.
 - Abatement system reliability. If, in the event of primary system failure, the process cannot be stopped quickly enough to prevent an emission then strong consideration should be given to the provision of a secondary back-up system.

Indicative BAT

You should where appropriate:

1. Consider all potential environmental impacts from the outset in any new project for manufacturing chemicals.
2. Undertake the appropriate stages of a formal HAZOP study as the project progresses through the process design and plant design phases. The HAZOP studies should consider amongst other things the points noted above.

Storage and handling of raw materials, products and wastes

Plant systems and equipment

2.2 Storage and handling of raw materials, products and wastes

The design of storage facilities depends upon the properties of the raw materials, products and wastes that are being stored. This includes their toxicity, environmental persistence and flammability. Storage areas are subject to the same risks as the main processing areas: overpressure, leakage, equipment failure and fire.

However the material inventories are generally greater and the level of surveillance is generally lower.

Additional guidance on the storage of chemicals is provided in the “Emissions from Storage” BREF (see Reference 3).

Indicative BAT

You should where appropriate:

1. Store reactive chemicals in such a way that they remain stable, such as under a steady gas stream, for example. If chemical additions are necessary then tests should be carried out to ensure the required chemical composition is maintained. Inhibitors may also be added to prevent reactions.
2. Vent storage tanks to a safe location.
3. Use measures to reduce the risk of contamination from large storage tanks. In addition to sealed bunds, use double-walled tanks and leak detection channels.
4. Use HAZOP studies to identify risks to the environment for all operations involving the storage and handling of chemicals and wastes. Where the risks are identified as significant, plans and timetables for improvements should be in place.

2.3 Plant systems and equipment

A wide range of ancillary equipment is required throughout the process, which may include: ventilation, pressure relief, vacuum raising, pumps, compressors, agitators, valves, purging and heating/cooling. Some of these systems give rise to a waste stream, e.g. wet vacuum systems or dust extraction equipment, and all of them have the

potential to give rise to fugitive emissions. You should formally consider potential emissions from plant systems and equipment such as:

- the concentration, mass-flow and impact of the substances vented to atmosphere
- the potential for contamination by extract air or rain-water run-off from the roof

Plant systems and equipment

- whether the ventilation system should be fed to an abatement unit
- noise levels and adequate silencing arrangements.

Valve leakage performance is significant in minimising fugitive losses and should be a major factor in valve selection. The duties

and conditions in each vessel and section of piping should be considered in a systematic HAZOP study to identify and quantify significant risks to the environment from the valves chosen for those parts of the plant activity in question.

Indicative BAT

You should where appropriate:

1. Formally consider potential emissions from plant systems and equipment and have plans and timetables for improvements, where the potential for substance or noise pollution from plant systems and equipment has been identified.
2. Carry out systematic HAZOP studies on all plant systems and equipment to identify and quantify risks to the environment.
3. Choose vacuum systems that are designed for the load and keep them well maintained. Install sufficient instrumentation to detect reduced performance and to warn that remedial action should be taken.

Over-pressure protection systems

Most pressurised vessels will use relief valves or bursting discs, or a combination of the two, to provide emergency pressure relief. Venting may be through an absorption system, to a dump tank or directly to atmosphere, and the need to collect and treat the release will depend on the likely impact of a discharge. The relief system must be designed to cope with all conceivable conditions, because the vented stream might be liquid or a two-phase foaming mixture, which would

impose different design constraints from simple gas relief. All equipment installed in the venting system should be maintained in a state of readiness even though the system is rarely used. Sometimes a small-capacity relief valve is installed, discharging to an abatement system, with, in parallel and at a slightly higher pressure setting and discharging directly to atmosphere, a large-capacity device to deal with fire induced relief.

Plant systems and equipment

Indicative BAT

You should where appropriate:

1. Carry out a systematic HAZOP study for all relief systems, to identify and quantify significant risks to the environment from the technique chosen.
2. Identify procedures to protect against overpressure of equipment. This requires the identification of all conceivable over-pressure situations, calculation of relief rates, selection of relief method, design of the vent system, discharge and disposal considerations, and dispersion calculations. In some cases careful design can provide intrinsic protection against all conceivable over-pressure scenarios, so relief systems and their consequential emissions can be avoided.
3. Maintain in a state of readiness all equipment installed in the venting system even though the system is rarely used.

Heat exchangers and cooling systems

All heat exchange systems have the potential for process streams to leak into the heating/cooling fluid, or vice versa. The “Industrial Cooling Systems” BREF

(see Reference 3) provides detailed information on BAT for water-cooled heat exchangers and cooling-tower systems.

Indicative BAT

You should where appropriate:

1. Consider leak detection, corrosion monitoring and materials of construction, preferably in a formal HAZOP study. Plans and timetables for improved procedures or replacement by higher integrity designs should be in place where the risks are identified as significant.
2. If corrosion is likely, ensure methods for rapid detection of leaks are in place and a regime of corrosion monitoring in operation at critical points. Alternatively, use materials of construction that are inert to the process and heating/cooling fluids under the conditions of operation.
3. For cooling water systems, use techniques that compare favourably with relevant techniques described in the Industrial Cooling Systems BREF.

Plant systems and equipment

Reaction stage

Purging facilities

Plant will normally require purging with air between batches and campaigns, and prior to maintenance activities; similarly, prior to start-up, air is often displaced from the system by an inert gas to ensure that a

flammable atmosphere does not form. Purging leads to non-condensable gases carrying organic vapours being vented from the system.

Indicative BAT

You should where appropriate:

1. Assess the potential for the release to air of VOCs and other pollutants along with discharged purge gas and use abatement where necessary.

2.4 Reaction stage

It is important to consider how the chemistry and engineering options may contribute to releases to the environment from the reaction stage, both directly and as a consequence later in the process. It is also important that these considerations are made at the process design stage - before plant design and equipment

selection is commenced. It is difficult to overstate the importance of an adequate understanding of the physical chemistry involved in the reaction scheme, followed by sound application of reactor engineering principles at the process design stage.

Indicative BAT

You should where appropriate:

1. With a clear understanding of the physical chemistry, evaluate options for suitable reactor types using chemical engineering principles.
2. Select the reactor system from a number of potentially suitable reactor designs - conventional stirred tank reactor (STR), process-intensive or novel-technology - by formal comparison of costs and business risks against the assessment of raw material efficiencies and environmental impacts for each of the options.
3. Undertake studies to review reactor design options based on process-optimisation where the activity is an existing activity and achieved raw material efficiencies and waste

Reaction stage

generation suggest there is significant potential for improvement. The studies should formally compare the costs and business risks, and raw material efficiencies and environmental impacts of the alternative systems with those of the existing system. The scope and depth of the studies should be in proportion to the potential for environmental improvement over the existing reaction system.

4. Maximise process yields from the selected reactor design, and minimise losses and emissions, by the formalised use of optimised process control and management procedures (both manual and computerised where appropriate).
5. Minimise the potential for the release of vapours to air from pressure relief systems and the potential for emissions of organic solvents into air or water, by formal consideration at the design stage - or formal review of the existing arrangements if that stage has passed.

Minimisation of vapour losses

There are many techniques for minimising the potential for vapour losses and for collection and abatement of vapour displaced into vent lines.

For example, during the charging of vessels, vapour losses can be reduced by using dip-pipe or bottom-filling instead of splash-filling from the top. This also reduces the risks of static-induced explosion. Organics evaporated from reactor systems can be collected ahead of

an abatement system in order to achieve direct recovery of the material, the most common method being condensation. You should always consider opportunities to enhance the performance of abatement systems, e.g. by increasing the heat transfer area or chilling the coolant medium for condensation, or by changing the packing or absorbent in absorption towers.

Indicative BAT

You should where appropriate:

1. Review your operating practices and review vent flows to see if improvements need to be made.
2. Consider opportunities to enhance the performance of abatement systems.

Separation stage

2.5 Separation stage

On completion of the reaction it is usually necessary to separate the desired product

from the other components in the reaction system.

Liquid-vapour separations

The most widely used vapour-liquid separation techniques are evaporation, steam- or gas-stripping and distillation. Contaminants in the liquid phase can

cause excessive foaming and the presence of inert non-condensable gases can depress the performance of condensers.

Indicative BAT

You should where appropriate:

1. Choose your separation technique following a detailed process design and HAZOP study. Follow formal operating instructions to ensure effective separation and minimisation of losses. Adhere to design conditions such as heat input, reflux flows and ratios, etc.
2. Install instrumentation to warn of faults in the system, such as a temperature, pressure or low coolant-flow alarms.

Liquid-liquid separations

The most widely used liquid-liquid separation techniques are 2-phase extraction with water or solvent, decantation, centrifuging and multi-stage contacting.

Small quantities of surfactant substances can affect dispersion and coalescence, and even with good separation there is usually a secondary haze which, typically, accounts for up to 1% of the required substance remaining in the wrong phase and ending up in the waste stream.

Separation Stage

Indicative BAT

You should where appropriate:

1. Use techniques which maximise physical separation of the phases (and also aim to minimise mutual solubility) where practicable.
2. When the phases are separated, use techniques which prevent (or minimise the probability and size of) breakthrough of the organics phase into a waste-water stream. This is particularly important where the environmental consequences of subsequent releases of organics to air or into controlled waters may be significant (e.g. where the effluent is treated in a DAF unit or some of the organic components are resistant to biological treatment).
3. Where you are discharging to drain, consider whether there should be an intermediate holding or "guard" tank to protect against accidental losses from the organics phase.

Solid-liquid separations

Different separation techniques will be BAT for different applications, with factors like solubility, crystallisation rate and granular size being important. The main

solid-liquid techniques are centrifuging, filtration, sedimentation, clarification, drying and ion exchange.

Indicative BAT

You should where appropriate:

1. Use techniques to minimise, re-use and/or recycle rinse water, and to prevent breakthrough of solids.
2. Install instrumentation or other means of detecting malfunction as all of the techniques are vulnerable to solids breakthrough.
3. Consider installing "guard" filters of smaller capacity downstream which, in the event of breakthrough, rapidly 'clog' and prevent further losses.
4. Have good management procedures to minimise loss of solids, escape of volatiles to air and excessive production of waste water.

Purification stage

2.6 Purification stage

Waste associated with the purification stage may arise from:

- Impurities in the raw materials - so a change in the raw material specifications may reduce waste arisings.

- By-products generated by the process - so a change in reaction conditions, catalyst, solvent, etc may improve the selectivity of the reaction and reduce or eliminate by-product formation.

Purification of liquid products

Liquid products are usually refined by distillation, with filtration used to remove solid contaminants. Sources of loss are:

- Gas entrainment. Gas or vapour flow will carry away volatile material either as vapour or as entrained droplets. Additional condenser heat-exchange area or colder heat-exchange fluid can improve the recovery rate, and coalescing demisters are relatively cheap and easy to install.
- Ineffective separation. A better separation in the distillation column can be achieved by using more stages

(theoretical plates) or more reflux. Modern types of packing or high-efficiency trays can often produce a marked improvement for a modest capital investment.

- Filtration. Enclosed filtration is usually used and this is not normally a source of great vapour loss to air. Liquid discharged during cleaning or changing of filters should be returned to the process.

Purification of solid products

Washing and crystallising activities have the potential to produce large volumes of dilute liquors so counter-current systems of operation should be used wherever possible.

During drying, you should aim to produce the maximum concentration of solvent in the gas to allow recovery of the solvent. The use of vacuum can improve both solvent recovery and energy efficiency.

Chemical process controls

Analysis

2.7 Chemical process controls

Reaction conditions such as temperatures, pressures, rocking or stirring rates, catalyst age, input and output flow rates,

addition of materials (and so on) are imperative to the efficient conversion of raw materials to product.

Indicative BAT

You should where appropriate:

1. Monitor the relevant process controls and set with alarms to ensure they do not go out of the required range.

2.8 Analysis

Indicative BAT

You should where appropriate:

1. Analyse the components and concentrations of by products and waste streams to ensure correct decisions are made regarding onward treatment or disposal. Keep detailed records of decisions based on this analysis in accordance with management systems.

3

Emissions and monitoring

3.1 Point source emissions

3.2 Fugitive emissions

3.3 Odour

3.4 Noise and vibration

3.5 Monitoring

Point source emissions

3. Emissions and monitoring

3.1 Point source emissions

Point source emissions to air

The diversity of this broad sector is such that a wide range of different emissions will arise. You should aim first to prevent emissions and then to minimise emissions at source. Only when you have done this should you use abatement techniques as necessary. You will often need a combination of techniques to abate emissions.

You should formally consider the following when dealing with your emissions to air:

- the information in this guidance note
- relevant equivalent sections in the guidance notes for the speciality organics chemical sector and the inorganic chemical sector
- the abatement guidance note
- the BREF on Common Waste Water and Waste Gas Treatment / Management Systems in the Chemical Sector
- other specific BREFs as relevant to the activity.

The selection of BAT for a specific installation will depend on many factors including:

- gas flow rate (average rate, range, rate of variation)

- pollutant types and inlet concentrations
- presence of impurities (e.g. water, dust, corrosives)
- concentration required in the exhaust
- safety
- investment and operating cost
- plant layout
- availability of utilities.

Depending on these factors, a combination of techniques may be needed to satisfy the requirements of BAT. Measures for prevention and minimisation should be applied, then abatement techniques used if necessary.

The benchmark values for point source emissions to air listed in Annex 1 are achievable using the techniques described in the BREF and we would expect you to use techniques that can achieve these values unless you have presented a cost benefit analysis to justify alternative values and we have agreed

Particulate matter

The methods available for minimising or reducing discharges of particulate matter to the atmosphere are described in the Abatement Guidance Note A3 (see Reference 3, Annex 2).

Point source emissions

General emissions

There are many methods available for reducing and minimising discharges of gaseous pollutants in emissions to atmosphere. Some of the main types are as follows:

- absorption
- condensation
- thermal decomposition
- adsorption
- filtration
- electrostatic precipitation.

Indicative BAT

You should where appropriate:

1. Formally consider the information and recommendations in the BREF on Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector (see Reference 1, Annex 2) as part of the assessment of BAT for point-source releases to air, in addition to the information in this guidance note.
2. Identify the main chemical constituents of the emissions, including VOC speciation where practicable.
3. Assess vent and chimney heights for dispersion capability and assess the fate of the substances emitted to the environment.
4. Use the following measures to minimise emissions to air:
 - recover emissions rich in organics by fractionation and then recycle
 - recover and reuse solvents
 - continuously monitor off-gas concentration from reaction vessels, dryers, condensers, evaporators and scrubbers where off-gases are shown to be environmentally significant.

Control of emissions of volatile organic compounds (VOCs)

The main issues that influence the selection and cost of VOC abatement techniques for this sector are:

- the intermittent nature of releases from batch processes
- and the complex nature of the gas streams involved, with many different

VOCs often being present as well as moisture, particulates and acid gases.

Both of these issues have a profound influence on the selection of abatement techniques.

Abatement of volatile organic compounds (VOCs) is described in the Abatement Guidance Note A3 (see Reference 3, Annex 2) and that note should be consulted where VOC emissions are significant.

Point source emissions

Before selecting the appropriate technique(s) it is important to quantify systematically flows, chemical compounds and concentrations over all potential operating conditions.

Quantification allows opportunities for in-process minimisation to be considered, as well as aiding in the selection of the appropriate abatement techniques. Particular attention may have to be given to vent header systems that receive gas streams from a number of different sources.

Techniques for the abatement of VOCs may be broadly characterised as those that:

- recover the VOC and offer the potential for recycle/re-use (adsorption, absorption and condensation)
- destroy the VOC (thermal, catalytic, flameless and biological oxidation, respectively)

Unless a viable recycle/re-use route is available for the former techniques, then there will still be a need for disposal. All of these techniques have been and will continue to be widely applied in the sector.

Point Source Emissions to Water

Water is used for some reactions (process water), for cooling and for cleaning.

Waste water streams can generally be categorized as:

- contaminated with hydrocarbons
- contaminated with heavy metals
- contaminated with chlorinated hydrocarbons, and/or
- acidic and alkaline.

It is unlikely that any single waste water treatment technique will be adequate to render harmless the waste water to be discharged. For example, a waste water stream with a low pH and a high organics content would require both pH adjustment and a means removing the organic compounds. Treatment methods should be applied as appropriate.

Useful in-plant treatment techniques include:

- For hydrocarbons, combinations of: air or steam stripping; granular activated carbon; ion exchange; reverse osmosis; electro dialysis; oxidation, including wet oxidation.
- For heavy metals, combinations of: oxidation/reduction; precipitation; filtration.
- For aqueous waste, wet air oxidation is generally more energy-efficient than incineration and is capable of oxidising complex molecules, including some

Point source emissions

pesticides, with up to 99.9% removal efficiencies. However, tests are normally required to confirm or otherwise the appropriateness of this technique.

Advantages of wet oxidation include:

- emissions of nitrogen oxides are virtually eliminated where the oxidation temperature is low
- emissions of dust or inorganic oxides are eliminated, and
- the oxidation is carried out in a closed system, which reduces the risk of release of unconverted material in the event of a process upset such as runaway reactions

Possible disadvantages include:

- a minimum concentration of oxidisable material is required to allow autothermal operation; below this concentration an extra energy source is required.

Where recovery or chemical treatment of liquid wastes is not feasible, thermal destruction is the next preferred alternative. A correctly designed and operated incinerator ensures a high degree of controlled combustion, allows recovery of heat and abatement of polluting emissions.

Indicative BAT

You should where appropriate:

1. Control all emissions to avoid a breach of water quality standards as a minimum. Where another technique can deliver better results at reasonable cost it will be considered BAT and should be used.
2. Use the following measures to minimise water use and emissions to water:
 - where water is needed for cooling, minimize its use by maximising heat transfer between process streams
 - use water in recirculating systems with indirect heat exchangers and a cooling tower rather than a once through system. (A water make-up treatment plant and a concentrated purge stream from the system to avoid the build up of contaminants are likely to be necessary.)
 - leaks of process fluids into cooling water in heat exchangers are a frequent source of contamination. Monitoring of the cooling water at relevant points should be appropriate to the nature of the process fluids. In a recirculatory cooling system, leaks can be identified before significant emission to the environment has occurred. The potential for environmental impact is likely to be greater from a once through system.

Point source emissions

Planned maintenance can help to avoid such occurrences

- water used for cleaning can be reduced by a number of techniques, e.g. by spray cleaning rather than whole vessel filling
- strip process liquor and treat if necessary, then recycle/reuse
- use wet air oxidation for low volumes of aqueous effluent with high levels of organic content, such as waste streams from condensers and scrubbers
- neutralise waste streams containing acids or alkalis to achieve the required pH for the receiving water
- strip chlorinated hydrocarbons in waste streams with air or steam and recycle by returning to process where possible
- recover co-products for re-use or sale
- periodically regenerate ion exchange columns
- pass waste water containing solids through settling tanks, prior to disposal
- treat waste waters containing chlorinated hydrocarbons separately where possible to ensure proper control and treatment of the chlorinated compounds. Contain released volatile chlorinated hydrocarbons and vent to suitably designed incineration equipment
- non-biodegradable organic material can be treated by thermal incineration. However, the thermal destruction of mixed liquids can be highly inefficient and the waste should be dewatered prior to incineration.

Point Source Emissions to Land

The wastes produced by the sector can be classified into types as follows:

- by-products for which no internal use or external sale is available
- residues from separation processes such as distillation
- catalysts which have declined in performance and require replacement
- filter cake, activated carbon, ion exchange resins, molecular sieves and other treatment materials
- sludges from waste water treatment
- emptied containers and packaging

- maintenance and construction materials.

Landfill may be suitable for a limited number of wastes which are non polluting or are solidified or encapsulated to prevent release of contaminants. For example, some metal compounds when treated with lime are highly insoluble. Landfill of wastes should only be contemplated after all other alternatives have been thoroughly examined and rejected.

Point source emissions

Fugitive Emissions

The following wastes are likely to be landfilled:

- spent process residues
- spent molecular sieve
- spent ion exchange resins
- polymer and sludge from reaction vessels.

Indicative BAT

You should where appropriate:

1. Use the following measures to minimise emissions to land:
 - use settling ponds to separate out sludge (Note: Sludge can be disposed of to incinerator, encapsulation, land or lagoon depending upon its make up.)
 - chlorinated residues should be incinerated and not released to land. (Chlorinated hydrocarbons are not to be released to the environment due to their high global warming and ozone depletion potentials.)
 - either recycle off spec product into the process or blend to make lower grade products where possible
 - many catalysts are based on precious metals and these should be recovered, usually by return to the supplier.

3.2 Fugitive emissions

Fugitive emissions of VOCs

Fugitive VOC emissions to air are often significant. Typical survey results show that leaks from glands on valves and pumps are responsible for 90% or more of estimated fugitive emissions and that a small proportion of valves, virtually all on

gas or high-temperature light material streams, contribute almost all of the total. Abatement of fugitive emissions is of particular importance for VOCs with a high environmental impact.

Fugitive Emissions

Indicative BAT

You should where appropriate:

1. Establish a fugitive release inventory for the installation. This is a major undertaking, which involves the following steps:
 - identifying all potential sources of VOC emissions, by establishing population counts of equipment components in line with up-to-date piping and instrumentation drawings for processes. This survey should cover gas, vapour and light liquid duties
 - quantifying the VOC emissions, initially as baseline estimates, and subsequently to more refined levels. Suitable protocols for this include the US EPA Method 21 for process component losses and API methods for tankage losses. Some major companies have developed their own techniques and protocols
 - using appropriate dispersion modelling techniques to predict atmospheric mass flux and concentrations
 - monitoring to compare the predicted situation with the measured one.
2. Have a permanent on-going leak detection and repair (LDAR) programme for process component fugitive emissions. This should be developed and tailored to suit the situation concerned. It should provide estimates of fugitive VOC emissions for monitoring returns and enable action to be taken to minimise emissions.
3. To minimise fugitive emissions you should:
 - use low-emission valve stem packing (500 ppm) on critical valves, eg rising-stem gate-type control valves in continuous operation, particularly on gas/light liquid high-pressure/temperature duties
 - use alternative proven types of low-release valves where gate valves are not essential, e.g. quarter-turn and sleeved plug valves, both of which have two independent seals
 - use balanced bellows-type relief valves to minimise valve leakage outside of design lift range and piping of reliefs to flare, normally via phase separation, without header back-pressure
 - minimise the number of flanged connections on pipelines and use high-specification jointing materials

Fugitive Emissions

- use canned pumps, magnetically driven pumps, or double seals on conventional pumps
- pipe compressor seals, vent and purge lines to flare systems
- use end caps or plugs on open-ended lines and closed loop flush on liquid sampling points
- minimise the emissions to air from process hydrocarbon analysers, by optimising sampling volume/frequency and venting to flare systems
- when transferring volatile liquids, use one or more of the following techniques: subsurface filling via filling pipes extended to the bottom of the container, vapour balance lines that transfer the vapour from the container being filled to the one being emptied, or an enclosed system with extraction to suitable abatement plant
- choose vent systems to minimise breathing emissions (for example pressure/vacuum valves) and, where relevant, fit knock-out pots and appropriate abatement equipment
- keep bulk storage temperatures as low as practicable, taking into account changes due to solar heating etc
- use the following techniques (together or in any combination) to reduce losses from storage tanks at atmospheric pressure:
 - tank paint with low solar absorbency
 - temperature control
 - tank insulation
 - inventory management
 - floating roof tanks
 - bladder roof tanks
 - pressure/vacuum valves, where tanks are designed to withstand pressure fluctuations
 - specific release treatment (such as adsorption condensation)

Fugitive Emissions

Fugitive emissions to surface water, sewer and groundwater

Fugitive emissions, primarily from leaks and spillages, may occur into cooling water, site drainage water and groundwater. Their control must form part

of a programme of good design, monitoring, maintenance and operating procedures.

Indicative BAT

You should where appropriate:

1. Provide hard surfacing in areas where accidental spillage or leakage may occur, e.g. beneath prime movers, pumps, in storage areas, and in handling, loading and unloading areas. The surfacing should be impermeable to process liquors.
2. Drain hard surfacing of areas subject to potential contamination so that potentially contaminated surface run-off does not discharge to ground.
3. Hold stocks of suitable absorbents at appropriate locations for use in mopping up minor leaks and spills, and dispose of to leak-proof containers.
4. Take particular care in areas of inherent sensitivity to groundwater pollution. Poorly maintained drainage systems are known to be the main cause of groundwater contamination and surface/above-ground drains are preferred to facilitate leak detection (and to reduce explosion risks).
5. Additional measures could be justified in locations of particular environmental sensitivity. Decisions on the measures to be taken should take account of the risk to groundwater.
6. Surveys of plant that may continue to contribute to leakage should also be considered, as part of an overall environmental management system. In particular, you should consider undertaking leakage tests and/or integrity surveys to confirm the containment of underground drains and tanks.

Odour

3.3 Odour

The requirements for odour control will be installation-specific and depend on the sources and nature of the potential odour.

Indicative BAT

You should where appropriate:

1. Manage the operations to prevent release of odour at all times.
2. Where odour releases are expected to be acknowledged in the permit, (i.e. contained and treated prior to discharge or discharged for atmospheric dispersion):
 - for existing installations, the releases should be modelled to demonstrate the odour impact at sensitive receptors. The target should be to minimise the frequency of exposure to ground level concentrations that are likely to cause annoyance
 - for new installations, or for significant changes, the releases should be modelled and it is expected that you will achieve the highest level of protection that is achievable with BAT from the outset
 - where there is no history of odour problems then modelling may not be required although it should be remembered that there can still be an underlying level of annoyance without complaints being made
 - where, despite all reasonable steps in the design of the plant, extreme weather or other incidents are liable, in our view, to increase the odour impact at receptors, you should take appropriate and timely action, as agreed with us, to prevent further annoyance (these agreed actions will be defined either in the permit or in an odour management statement).
3. Where odour generating activities take place in the open, or potentially odorous materials are stored outside, a high level of management control and use of best practice will be expected.
4. Where an installation releases odours but has a low environmental impact by virtue of its remoteness from sensitive receptors, it is expected that you will work towards achieving the standards described in this guidance note, but the timescales allowed to achieve this might be adjusted according to the perceived risk.
5. Where further guidance is needed to meet local needs, refer to Horizontal Guidance Note H4 Odour (see GTBR).

Noise and vibration Monitoring

3.4 Noise and vibration

Noise surveys, measurement, investigation (which can involve detailed assessment of sound power levels for individual items of plant) or modelling may be necessary for either new or existing installations depending upon the potential for noise problems. You may have a noise management plan as part of your management system.

Flares are a particular source of noise, often associated with steam injection for smoke suppression. Good design of flares tips can lessen the need for high rates of steam injection and provide quieter operation. The operation of safety valves and other release devices for high pressure systems can be extremely noisy.

Indicative BAT

You should where appropriate:

1. Install particularly noisy machines such as compactors and pelletisers in a noise control booth or encapsulate the noise source.
2. Limit the use of flares to emergency conditions.
3. Where possible without compromising safety, fit suitable silencers on safety valves.
4. Minimise the blow-off from boilers and air compressors, for example during start up, and provide silencers.

3.5 Monitoring and reporting of emissions to air and water

There is a suite of Environment Agency guidance on monitoring, known as the M series, which is included in the list of references in Annex 1 of GTBR.

Monitoring

Indicative BAT

You should where appropriate:

1. Carry out an analysis covering a broad spectrum of substances to establish that all relevant substances have been taken into account when setting the release limits. The need to repeat such a test will depend upon the potential variability in the process and, for example, the potential for contamination of raw materials. Where there is such potential, tests may be appropriate.
2. Monitor more regularly any substances found to be of concern, or any other individual substances to which the local environment may be susceptible and upon which the operations may impact. This would particularly apply to the common pesticides and heavy metals. Using composite samples is the technique most likely to be appropriate where the concentration does not vary excessively.
3. If there are releases of substances that are more difficult to measure and whose capacity for harm is uncertain, particularly when combined with other substances, then "whole effluent toxicity" monitoring techniques can be appropriate to provide direct measurements of harm, for example, direct toxicity assessment.

Monitoring and reporting of waste emissions

Indicative BAT

You should where appropriate:

1. Monitor and record:
 - the physical and chemical composition of the waste
 - its hazard characteristics
 - handling precautions and substances with which it cannot be mixed.

Monitoring

Environmental monitoring (beyond installation)

Indicative BAT

You should where environmental monitoring is needed:

1 Consider the following in drawing up proposals:

- determinands to be monitored, standard reference methods, sampling protocols
- monitoring strategy, selection of monitoring points, optimisation of monitoring approach
- determination of background levels contributed by other sources
- uncertainty for the employed methodologies and the resultant overall uncertainty of measurement
- quality assurance (QA) and quality control (QC) protocols, equipment calibration and maintenance, sample storage and chain of custody/audit trail
- reporting procedures, data storage, interpretation and review of results, reporting format for the provision of information.

4

Annexes

Annex 1 Emission benchmarks

**Annex 2 Other relevant guidance
and abbreviations**

Annex 1-Emission benchmarks

4. Annexes

Annex 1- Emission benchmarks

Emissions to air

This guidance covers a wide range of chemical processes and abatement techniques. Although continuous monitoring should be undertaken wherever

practicable, the small scale and batch nature of many processes in the sector will make period testing at critical stages in the batch more appropriate.

Released substance	Source processes	Benchmark value (mg/Nm ³) (a)	Type and frequency of monitoring	Comments; abatement system
Acrylamide		5	Continuous	
Acrylonitrile	Adiponitrile, acrylamide, ABS polymers	0.5 - 2	Continuous	0.5mg/m ³ for incineration, 2 for scrubbing
Amines (total, as DMA)	DMAE, DMCHA, DMF, DMAC	10	Continuous	
Ammonia	Amines, ethanolamines	10	Continuous	
Benzene	Ethylbenzene, nitrobenzene, cumene etc.	5	Continuous	
Bromine	Brominated hydrocarbons	10	Continuous	
Butadiene	Hydrocarbons	5	Continuous	
Cadmium and cpds (as Cd)(a)	Incineration	0.1	Periodic See HWID	
Carbon disulphide	Dithiocarbamates, thiophene, mercapto-benzothiazole	5	Continuous	
Carbon	Combustion, incineration,	100	Continuous	

Annex 1-Emission benchmarks

monoxide	acetic acid, OXO processes, DMF			
Chlorine	Chlorinated hydrocarbons	10	Continuous	
1,2-dichloroethane	VCM	1 - 5	Continuous	1mg/m ³ for incineration treatment
Ethylene Oxide	Ethylene glycol, glycolethers, ethanolamines, polyglycols, choline chloride, hydroxyl acrylates etc.	2	Continuous	Water scrubbing
Formaldehyde	Resins	5 – 10 5mg/Nm ³ by incineration.	Continuous	2mg/m ³ by incineration; 10mg/m ³ by catalytic oxidation
Hydrogen bromide	Brominated hydrocarbons	5	Continuous	
Hydrogen chloride	Chlorinated hydrocarbons	10	Continuous	
Hydrogen cyanide	Acrylonitrile	2	Continuous	
Hydrogen fluoride	Hydrofluorocarbons, alkylations processes	5	Continuous	
Hydrogen iodide		5	Periodic (monthly)	
Hydrogen sulphide	Dithiocarbamates, thiols, thiophene	5	Continuous	

Annex 1-Emission benchmarks

Released substance	Source processes	Benchmark value (mg/Nm ³) (a)	Type and frequency of monitoring	Comments; abatement system
Heavy metals (excl. Hg, Cd) (a)	Incineration, catalyst regeneration	1.5	Periodic See WID	
Iodine	Acetic Acid	10	Periodic (monthly)	
Maleic anhydride	Resins	5	Periodic (monthly)	
Mercury and cpds (as Hg) (a)	Incineration	0.05	Periodic See HWID	
Methyl mercaptan		2	Continuous	
Nitrobenzene	Aniline	5	Continuous	
Organic sulphides and mercaptans (as H ₂ S)		2	Continuous	
Oxides of sulphur (as SO ₂)	Sulphonation, combustion	50 - 100	Continuous	50mg/m ³ by wet scrubbing; 100 by semi-dry
Oxides of nitrogen (total acid-forming as NO ₂)	Nitration, combustion	50 - 200	Continuous	50mg/m ³ by SCR, 200 mg/m ³ by wet scrubbing
Particulate matter	Polymers, resins	5 - 20	Continuous	5 mg/m ³ by fabric filter, 20mg/m ³ by ESP
Phenols, cresols and xylols (as phenol)	Cumene, adipic acid, resins	10	Continuous/ periodic (monthly)	

Annex 1-Emission benchmarks

Trimethylamine		2	Continuous	
Vinyl chloride (b)	PVC, copolymers See note b	1 - 5	Continuous	1mg/m ³ by incineration treatment
VOC total Class A (c)	See note c	20	Continuous	
VOC Total Class B (c) (expressed as carbon)	See note c	75	Continuous	
Dioxins and furans (ng TEQ/m ³)	Incinerators, DCE and VCM processes	0.1	Periodic	See HWID

Note (a):

- The reference conditions applicable to these levels are: temperature 273 K (0°C), pressure 101.3 kPa (1 atmosphere), no correction for water vapour or oxygen.
- Where the term "expressed as" is used, a correction should be carried out using the ratio of the atomic or molecular weights of the substances as appropriate.
- All releases should be essentially colourless, free from persistent trailing mist or fume and free from droplets.
- Releases from the installation should not give rise to an offensive odour noticeable outside the site where the process is carried on.

Note (b): OSPARCOM Recommendation 98/4 relates to BAT for the manufacture of vinyl chloride monomer, 98/5 to suspension PVC.

- For PVC manufacture, the following release rates are achievable:
 - Emulsion process - total VCM release from all vessel vents 1.0 kg/tonne PVC
 - Suspension process - total VCM release from all vents 0.1 kg/tonne PVC

Note (c):

- Releases of VOCs should be individually identified, where possible. The VOC concentration levels generally apply where the following total mass release rates are exceeded:
 - Total Class A 100g/h (expressed as individual VOCs)

Annex 1-Emission benchmarks

- Total Class B 5 tonne/yr or 2 kg/h, whichever is the lower (expressed as carbon)
- Note, however, that releases below these mass emission rates may not be trivial, and so may still require controls and the setting of appropriate emission limits values.
- The use of a concentration limit is not normally appropriate in the case of an emission from an airdeficient saturated vapour space such as a storage tank or process vessel. An approach based on limiting total mass released or mass per unit of production is likely to be more effective.
- The term "Volatile Organic Compounds" includes all organic compounds released to air in the gas phase.

Emissions to water associated with the use of BAT

Wastewater treatment systems can maximise the removal of metals using precipitation, sedimentation and possibly filtration. The reagents used for precipitation may be hydroxide, sulphide or a combination of both, depending on the mix of metals present. It is also practicable in many cases to re-use treated water.

Where automatic sampling systems are employed, limits may be defined such that:

- not more than 5% of samples shall exceed the benchmark value

Where spot samples are taken:

- no spot sample shall exceed the benchmark value by more than 50%

The substances to be monitored should be selected according to the potential for their emission from the process and their subsequent impact.

Annex 1-Emission benchmarks

Substance	Level (mg/l) Note (a)
Total hydrocarbon oil content (IR method)	1-3
Biological oxygen demand (BOD) (5 day ATU @ 20oC)	20-30
Chemical oxygen demand (COD) (2 hour)	30-125
Total nitrogen (as N)	10-15
Suspended solids (dried @ 105oC)	20-30
Emission	
Halogenated Organic Compounds AOX Notes (b) and (d)	1
Mercury	0.05
Cadmium	0.2
Copper, chromium, nickel and lead (each)	0.5
Zinc and tin (each)	2

Note (a):

The levels given are ranges achievable after effluent treatment and are not emission limit values. They are given on the basis of flow-weighted monthly averages.

For pollutants resistant to biodegradation, achievement of the levels will require isolation at source and separate specialised treatment.

On-site effluent treatment is preferred for these processes. Where discharge to sewer is proposed, the applicant should demonstrate that this option represents BAT, taking into account:

- the substances released and their separability and degradability
- the type of sewage treatment available

Annex 1-Emission benchmarks

- the security of the sewage treatment system, e.g. with regard to storm overflow
- the relative performance of the available sewage treatment compared with that of the site dedicated Option

Compliance with limits imposed by the sewerage undertaker does not guarantee compliance with BAT.

Note (b):

EC Directive 90/415/EEC(14) gives limits for releases to water from the production and use of 1,2- dichloroethane, trichloroethylene, perchloroethylene and trichlorobenzene.

Note (c):

SI 1989 No 2286(15) gives annual mean concentration standards for certain dangerous substances in receiving waters.

Annex 2-Other relevant guidance and abbreviations

Annex 2- Other relevant guidance and abbreviations

For a full list of available Technical Guidance and other relevant guidance see Appendix A of GTBR (see <http://publications.environment-agency.gov.uk/pdf/GEHO0908BOTD-e-e.pdf?lang=e>).

In addition to the guidance in GTBR the following guidance is relevant to this sector:

References 1 IPPC Reference Document on Best Available Techniques in the Large Volume Organic Chemical Industry European Commission
<http://eippcb.jrc.ec.europa.eu/pages/BActivities.cfm>

BREFS with relevance to the Speciality Organic Chemicals sector include:

- Common Waste Water and Waste Gas Treatment and Management Systems in the Chemical Sector, (February 2003)
- Economic and Cross-media Issues Under IPPC, (July 2006)
- Emissions from Storage of Bulk or Dangerous Materials, (July 2006)
- Monitoring Systems, (July 2003)
- Cooling Systems, (December 2001)
- Large Volume Organic Chemicals, (February 2003)
- Refineries, (February 2003)
- Waste Treatments, (August 2006)

Reference 2 Sector Plan for the Chemicals Industry. <http://publications.environment-agency.gov.uk/pdf/GEHO1105BJVM-e-e.pdf>

Reference 3 Releases to air references:

- Part B PG1/3 Boilers and Furnaces 20-50 MW net thermal input (ISBN 0-11-753146-4-7)
- Part B PG1/4 Gas Turbines 20-50 MW net thermal input (ISBN 0-11-753147-2)
- Pollution abatement technology for particulate and trace gas removal, HMIP Technical Guidance Note (Abatement) A3, 1994, ISBN 0-11-752983-4 www.tso.co.uk/bookshop

Annex 2-Other relevant guidance and abbreviations

Reference 4 Releases to water references:

- A4 Effluent Treatment Techniques, TGN A4, Environment Agency, ISBN 0-11-310127-9 (EA website)

Reference 5 Volatile Organic Compounds

- The Categorisation of Volatile Organic Compounds, 1995 HMIP Research Report No DOE/HMIP/RR/95/009 (www.environment-agency.gov.uk)
- Pollution abatement technology for the reduction of solvent vapour emissions, HMIP Technical Guidance Note (Abatement) A2, 1994, ISBN 0-11-752925-7 www.tso.co.uk/bookshop

Reference 6 Novel reactor and Process Intensification papers

- Chemical reaction engineering: A multi-scale approach to a multi-objective task. Jan Lerou & Ka Ng, DuPont Central Research and Development - Chemical Engineering Science, Vol 51, No 10, pp 1595-1614, 1996 (Copyright Elsevier Science Ltd) • Alternative multiphase reactors for fine chemicals. A world beyond stirred tanks? E H Stitt, Syntex, Chemical Engineering Journal 90 (2002) pp 47-60 www.elsevier.com/locate/cej
- 3rd International Conference on Process Intensification for the Chemical Industry - Smaller, Cheaper and Safer Production, Antwerp, Belgium, 25-27 October 1999, Proceedings published by BHR Group Limited ISBN 1-86058-215X www.bhrgroup.co.uk
- 4th International Conference on Process Intensification for the Chemical Industry - Better Processes for Better Products, Brugge, Belgium, 10-12 September 2001, Proceedings published by BHR Group Limited ISBN 1-85598-0363 www.bhrgroup.co.uk
- Process intensification: transforming chemical engineering, A Stankiewicz & J A Moulijn, Chemical Engineering Progress, January 2000, pp 22-34, Published by AIChE. www.cepmagazine.org
- ATLAS Project, 1996-7 EU research programme into innovative technologies, oriented towards (but not exclusively) energy efficiency techniques [http:// europa.eu.int/comm/energy_transport/atlasGuida](http://europa.eu.int/comm/energy_transport/atlasGuida)

Annex 2-Other relevant guidance and abbreviations

Abbreviations

BAT	Best Available Techniques
BOD	Biochemical Oxygen Demand
BREF	BAT Reference Document
CEM	Continuous Emissions Monitoring
CHP	Combined heat and power plant
COD	Chemical Oxygen Demand
ELV	Emission Limit Value
EMS	Environmental Management System
EQS	Environmental Quality Standard
ETP	Effluent treatment plant
FOG	Fat Oil Grease
ITEQ	International Toxicity Equivalents
MCERTS	Monitoring Certification Scheme
SEC _p	Specific Energy consumption
TSS	Suspended solids
TOC	Total Organic Carbon
VOC	Volatile organic compounds

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