Cyfoeth Naturiol Cymru
Natural Resources Wales

How to comply with your environmental permit

Additional guidance for:

Speciality Organic Chemicals Sector (EPR 4.02)

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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 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 mainly covers installations for the manufacture of organic chemicals on a small or medium scale, principally by batch operations. It covers the manufacture of fine organic chemicals, the chemical production of explosives, pharmaceuticals and plant health products, the formulation of pharmaceuticals and plant health products. It is also intended to cover some activities that may be undertaken outside of chemical installations – i.e. those involving the polymerisation of unsaturated hydrocarbons or vinyl chloride, or the use of isocyanate-containing materials. However, because the sector is very diverse not all relevant activities operating in the UK can be described. The note is not intended to coincide precisely with all the "organic chemical" sections of the Regulations - particularly as large volume organic chemical production is covered in its own EPR guidance note and associated BREF document (see References).

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 azocompounds, nitrates, nitriles, nitrogen heterocyclics, cyanates, isocyanates, di-isocyanates and diisocyanate prepolymers

(v) organic compounds containing phosphorus, such as substituted phosphines and phosphate esters

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

(vii)organometallic compounds, such as lead alkyls, Grignard reagents and lithium alkyls

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

(ix) synthetic rubbers

(x) dyes and pigments

(xi) surface-active agents

(b) Producing any other organic compounds not described in paragraph

(c) Polymerising or co-polymerising any unsaturated hydrocarbon or vinyl chloride (other than a preformulated resin or preformulated gel coat which contains any unsaturated hydrocarbon) which is likely to involve, in any period of 12 months, the polymerisation or co-polymerisation of 50 tonnes or more of any of those materials or, in aggregate, of any combination of those materials.

(e) Any activity involving the use in any period of 12 months of one tonne or more of toluene di-isocyanate or other diisocyanate of comparable volatility or, where partly polymerised, the use of partly polymerised di-isocyanates or prepolymers containing one tonne or more of those monomers, if the activity may result in a release into the air which contains such a di-isocyanate monomer.

(f) The flame bonding of polyurethane foams or polyurethane elastomers.

(g) Recovering:

(i) carbon disulphide

(ii) pyridine or any substituted pyridine

(h) Recovering or purifying acrylic acid, substituted acrylic acid or any ester of acrylic acid or of substituted acrylic acid.

Section 4.4 - Plant Health Products and Biocides

Producing plant health products or biocides.

Section 4.5 - Pharmaceutical Production

(a) Producing pharmaceutical products using a chemical or biological process.
(b) Formulating such products if this may result in the release into water of any substance listed in paragraph 13 of Part 2 of this Schedule in a quantity which, in any period of 12 months, is greater than the background quantity by more than the amount specified in that paragraph for that substance.

Section 4.6 - Explosives Production

(a) Producing explosives.

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 emissions and pollution. These may involve activities such as:

- storage and handling of raw materials
- storage and despatch 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

Key issues

The key environmental issues for the speciality organic chemical manufacturing sector are:

Optimisation of the reaction stage

The speciality chemicals manufacturing sector overwhelmingly uses stirred tank reactors (STRs) in batch mode at the reaction stages, because this offers wide flexibility in the types of reactions that can be carried out. However, this flexibility can be at the expense of reaction specificity and may necessitate substantial downstream separation and purification stages which generate both waste waters and waste organic solids or liquids. Low inventory "fast" reactors and other “process intensification” techniques can improve this. You should consider using alternative reaction techniques where there is significant scope for improving raw material or energy efficiencies, and particularly where multiple batches of near-identical syntheses are planned.

Reaction optimisation tends to be a particular problem on multi-product tollconversion plants. BAT for the whole range of preparations is less likely to be met where just a few different STRs are used. You should investigate alternative reaction arrangements to seek a better appropriate technique for the medium to longer term if:

- general-purpose reactors are in use (or are proposed for use)
- raw material/energy inefficiencies and pollution/waste generation impacts have been assessed and found to be significant.

Point source emissions to water

Producing effluent streams containing complex pollutants such as mixed soluble and insoluble organics, chlorinated hydrocarbons, heavy metals, or nonbiodegradable 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.

Point source emissions of organics to water

Many organic preparative stages involve mixed volumes of aqueous and organic phases, either in the stirred-tank reactor itself (if used) or in subsequent extraction, separation or purification stages. This often leads to considerable amounts of aqueous effluent containing organics. Some of these effluent streams are easily treatable by in-house biological treatment plant or by a sewage treatment works. However many streams contain more intractable pollutants such as complex organics, chlorinated hydrocarbons or heavy metals. These place great demands on treatment works and can lead ultimately to unacceptable discharges to controlled waters or unacceptable pollutant loadings in sewage sludge.

The key issue is to avoid, as far as is practicable, the generation of these contaminated aqueous streams and to minimise the volume when generation is impossible.

Waste minimisation and waste disposal routes

As with waste water generation, 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 again is to avoid waste generation in the first place by optimizing the reaction arrangements.

Better disposal routes to minimize disposals to landfill is also key.

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 organic compounds.

Releases from point sources should be individually characterised , including those from process and storage vessels as well as those from abatement systems.

Fugitive emissions of VOCs to air

There are a considerable numbers of plant items which can leak VOCs. These include: flanges, pumps and valves with seals, storage tanks, tanker connections, sample points, etc. A significant number of joints and vessels are opened on a regular basis. In addition, solvents and other VOCs in aqueous waste streams can escape to air from open drains or be released in water treatment facilities. It is possible to reduce emissions of VOCs from all these sources.

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.

Energy efficiency

Speciality chemical installations tend to use a significant amount of energy per tonne of output. Some participate in a Climate Change Agreement or a Direct Participant Agreement (which are deemed to satisfy the BAT requirement for energy efficiency). However, even at these installations there may be some issues which should be considered in the EPR application and permitting process (e.g. the use in the medium to longer term of appropriate “process intensification” techniques).

Chemical analysis and monitoring of emissions

It has become the norm to report emissions on a national basis and to make comparisons via databases like the Pollution Inventory (PI) or the European Pollutant Emission Register (EPER). It is therefore vital to be consistent with streams from batch processes, with the substances that are monitored and with 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
1.5 Avoidance, recovery and disposal of wastes

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 Natural Resources Wales 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.

Indicative BAT

You should where appropriate:

1. Assess the environmental impact of each process and choose the one with the lowest environmental impact. (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.

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.

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.

Indicative BAT for waste recovery

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. Provide a detailed assessment identifying the best environmental options for waste disposal where you cannot avoid disposing of waste.

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

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.

All realistic options for minimising pollution should have been considered 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 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.

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, for example 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 air impact of the substances vented to atmosphere
- the potential for contamination by extract air of rain-water run-off from the roof
- 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. Emergency venting may be through an absorption system, to a dump tank or directly to atmosphere, and the need for equipment to collect and treat the release will depend on the likely impact of a discharge. It is imperative that the relief system is designed to cope with all conceivable conditions, because under some emergency situations the vented stream might be liquid or a two-phase foaming mixture, which would impose a different set of 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. Relief valves may be mounted downstream of bursting discs or between pairs of bursting discs to protect the valve seats from corrosion, with pressure gauges and alarms installed between the discs and valve to warn of perforation of a disc or operation of the relief device. 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.

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.

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. Newer techniques involving small, low-inventory "fast" reactors have the potential to achieve better yields whilst generating considerably lower quantities of organic waste and

waste-water contaminated by organics. These usually operate continuously (allowing a steady state to be attained with obvious simplification of control and improved product consistency/quality) or semi-continuously where a batch of reactants is prepared before being processed through the reactor. Individual fast reactors are usually custom-built for each reaction in order to optimise reaction specificity and maximise yields - and though they may appear to offer less flexibility than conventional reactor systems, in many cases the equipment is so small that individual pieces can be constructed cheaply and installed easily whenever a reaction change is required. This is a good illustration of why proper attention to process design before starting plant design pays dividends.

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 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 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 liquid losses from reaction systems

Different products are often made in successive campaigns, and at the end of each campaign it is important to remove as much potential contamination by the preceding batch as possible. This gives rise to waste.

Indicative BAT

You should where appropriate:

1. Use the following features that contribute to a reduction in waste arisings from clean-outs:

- low-inventory continuous throughput reactors with minimum surface area for cleaning
- minimum internals such as baffles and coils in the reactor
- smooth reactor walls, no crevices
- flush bottom outlet on reaction vessels
- all associated piping to slope back to the reactor or to a drain point
- sufficient headroom under the reactor for collection of all concentrated drainings in drums or other suitable vessel, if necessary
- minimal pipework, designed to eliminate hold-up and to assist drainage
- pipework designed to allow air or nitrogen blowing
- system kept warm during emptying to facilitate draining
- HAZOP studies used to assess the potential for the choking of lines by high-melting-point material
- campaigns sequenced so that cleaning between batches is minimised
- campaigns made as long as possible to reduce the number of product change-overs
- where a complete clean is necessary, use cleaning methods that minimise the use of cleaning agents, (e.g. steam-cleaning, rotating spray jets or high-pressure cleaning) or use a solvent which can be re-used
- carry out HAZOP studies to minimise the generation of wastes and to examine their treatment/disposal
- consider use of disposable plastic pipe-liners eliminate or minimise.locations for solids to settle-out
- consider duplicate or dedicated equipment where it can reduce the need for cleaning that is difficult.

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.

2.5 Separation stages

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. In batch operations, a common problem which results in loss of organics to drain is detection of the interface between the aqueous phase and the organics phase and stopping the flow in time.

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.

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

2.7 Chemical process control

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

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 large volume organics chemical sector and the inorganic chemical sector
- the abatement guidance note
- the BREF on Common Waste Water and Waste GasTreatment/ 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

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) as part of the assessment of BAT for point-source releases to air, in addition to the information in this 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.

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; electrodialysis; 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 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. 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

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.

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 to Air

On many installations fugitive emissions may be more significant than point source emissions. Fugitive VOC emissions are very likely from this sector - from phase-separations, valve glands and STR cleaning or charging, for example.

Indicative BAT

You should where appropriate:
1. Identify all potential sources and develop and maintain procedures for monitoring and eliminating or minimising leaks and releases of VOCs from all non-process stream sources.
2. Choose vent systems to minimise breathing emissions (for example pressure/ vacuum valves) and, where relevant, should be fitted with knock-out pots and appropriate abatement equipment.
3. Use the following techniques (together or in any combination) to reduce losses from storage tanks at atmospheric pressure:

    - maintenance of bulk storage temperatures as low as practicable, taking into account changes due to solar heating etc.
    - 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 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, taking into consideration the factors outlined in the Agency document, Policy and Practice for the Protection of Groundwater, including groundwater vulnerability and the presence of groundwater protection zones.
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.

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).

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. 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. Where possible without compromising safety, fit suitable silencers on safety valves.
3. 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.

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

4 Annexes

Annex 1 Emission benchmarks

Annex 2 Other relevant guidance and abbreviations

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	Benchmark Value (mg/Nm^3) (a)	Comments (Based on IPC S2 4.02 unless indicated from information in LVOC or Waste Water/ Waste Gas Treatment BREFs)
Active ingredients (pharmaceuticals, agrochemicals, etc)	0.15	
Amines (total, as DMA)	10	
Ammonia	10	BREFs (acid scrubbing)
Benzene	5	
Bromine	10	
Cadmium and cpds (as Cd)	0.1	
Carbon disulphide	5	
Carbon monoxide	100	
Chlorine	10	
1,2-dichloroethane	1 - 5	BREFs (1mg/Nm^3 by incineration treatment)
Formaldehyde	5- incineration 10- catalytic oxidation	BREFs
Fluorine and cpds (as HF)	5	
Hydrogen bromide	5	
Hydrogen chloride	10	

Hydrogen cyanide	2	
Hydrogen fluoride	5	
Hydrogen iodide	5	
Hydrogen sulphide	5	
Iodine	10	

Released substance	Benchmark Value (mg/Nm^3) (a)	Comments (Based on IPC S2 4.02 unless indicated from information in LVOC or Waste Water/ Waste Gas Treatment BREFs)
Lead and cpds (Total particulate as Pb)	4	
Lead compounds (Total nonparticulate as Pb)	20	
Mercury and cpds (as Hg)	0.1	
Nitrobenzene	5	
Nitropropane	5	
Organic sulphides and mercaptans (as H_2S)	2	
Oxides of sulphur (as SO_2) Phosgene 1 Tetrachloroethane 1 - 5 BREFs (1mg/m^3 by incineration treatment)	50 - 100	BREFs (50mg/m^3 by wet scrubbing)

Oxides of nitrogen (acid-forming oxides, as NO_2)	50 - 200	BREFs (50mg/m^3 by SCR, 200 mg/m^3 by wet scrubbing)
Particulate matter	5 - 20	BREFs (5 mg/m^3 by fabric filter, 20mg/m^3 by ESP)
Phenols, cresols and xylols (as phenol)	10	
Phosgene	1	
Tetrachloroethane	1 - 5	BREFs (1mg/m^3 by incineration treatment)
Trimethylamine	2	

Released substance	Benchmark Value (mg/Nm^3) (a)	Comments (Based on IPC S2 4.02 unless indicated from information in LVOC or Waste Water/ Waste Gas Treatment BREFs)
Vinyl chloride	1 - 5	BREFs (1mg/m^3 by incineration treatment)
Vinyl	1 - 5	chloride BREFs (1mg/m^3 by incineration treatment)
VOC total Class A (b)	20	
VOC Total Class B (b) (expressed as carbon)	75	

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):

- 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)

  – 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, sulphidor 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.

Discharged substance	Benchmark values (mg/l) (a)	Comments
Total hydrocarbon oil content (IR method)	1-3	
Biological oxygen demand (BOD) (5 day ATU @ 20°C)	20-30	
Chemical oxygen demand (COD) (2 hour)	30 - 125	(from BREFs)
Ammoniacal nitrogen (as N)	10-20	
Suspended solids (dried at 105°C)	20-30	(from BREFs)

Pesticides and chlorinated organic compounds(b, c)	See TGN A4	

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
- 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

For a full list of available Technical Guidance and other relevant guidance see Appendix A of GTBR

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

Reference 1 IPPC Reference Document on Best Available Techniques in the Large Volume Organic Chemical Industry European Commission

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)

Reference 4 Releases to water references:

- A4 Effluent Treatment Techniques, TGN A4, Environment Agency, ISBN 0-11-310127-9

Reference 5 Volatile Organic Compounds

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

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, Synetix, Chemical Engineering Journal 90 (2002) pp 47-60

- 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
- 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 Process intensification: transforming chemical engineering, A Stankiewicz & J A Moulijn, Chemical Engineering Progress, January 2000, pp 22-34, Published by AIChE.
- ATLAS Project, 1996-7 EU research programme into innovative technologies, oriented towards (but not exclusively) energy efficiciency techniques

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

SECp Specific Energy consumption

TSS Suspended solids

TOC Total Organic Carbon
VOC Volatile organic compounds