EUROPEAN COMMISSION

Integrated Pollution Prevention and Control

Reference Document on Best Available Techniques in Common Waste Water and Waste Gas Treatment / Management Systems in the Chemical Sector

February 2003

EXECUTIVE SUMMARY

INTRODUCTION

The BREF (Best Available Techniques reference document) on waste water and waste gas treatment and management in the chemical sector reflects an information exchange carried out under Article 16(2) of Council Directive 96/61/EC. This Executive Summary – which is intended to be read in conjunction with the BREF Preface's explanations of objectives, usage and legal terms – describes the main findings, the principal BAT conclusions and the associated emission levels. It can be read and understood as a stand-alone document but, as a summary, it does not present all the complexities of the full BREF text. It is therefore not intended as a substitute for the full BREF text as a tool in BAT decision making.

Waste water and waste gas handling has been identified as a horizontal issue for the chemical sector as it is described in Annex I, 4 of the Directive. It means that the term "Best Available Techniques (BAT)" is assessed in this document for the entire chemical sector, independently of the particular production process(es) and the kind or size of the chemical enterprise(s) involved. It also means that the term BAT needs to include, apart from treatment technologies, a management strategy to achieve optimal waste prevention or control.

Thus the scope of the document comprises:

- the application of environmental management systems and tools
- the application of the treatment technology for waste water and waste gas as it is commonly used or applicable in the chemical sector, including the treatment technology for waste water sludge, as long as it is operated on the chemical industry site
- the identification of or conclusion on best available techniques based on the two preceding items, resulting in a strategy of optimum pollution reduction and, under appropriate conditions, in BAT-associated emission levels at the discharge point to the environment.

Only commonly applied or applicable techniques for the chemical industry are dealt with in this document, leaving process-specific techniques or process-integrated techniques (i.e. non-treatment techniques) to the vertical process BREFs. Though restricted to the chemical industry, it is recognised that the document might also contain valuable information for other sectors (e.g. the refinery sector).

GENERAL ISSUES (CHAPTER 1)

Discharges to air and water are the main environmental impacts caused by releases from chemical installations.

The main sources of **waste water** in the chemical industry are:

- chemical syntheses
- waste gas treatment systems
- conditioning of utility water
- bleed from boiler feed water systems
- blowdown from cooling cycles
- backwashing of filters and ion exchangers
- landfill leachates
- rainwater from contaminated areas, etc.,

their main impact being characterised by:

- hydraulic load
- content of pollutant substances (expressed as load or concentration)
- effect or hazardous potential on the receiving water body, expressed as surrogate or sum parameters
- effect on organisms in the receiving water body, expressed as toxicity data.

Waste gas emissions appear as:

- ducted emissions, which are the only emissions that can be treated
- diffuse emissions
- fugitive emissions.

The main air pollutants are:

- VOCs
- sulphur compounds (SO_2, SO_3, H_2S, CS_2, COS)
- nitrogen compounds (NO_x, N_2O, NH_3, HCN)
- halogen compounds (Cl_2, Br_2, HF, HCl, HBr)
- incomplete combustion compounds (CO, C_xH_y)
- particulate matter.

MANAGEMENT SYSTEMS AND TOOLS (CHAPTER 2)

Environmental management is a strategy for dealing with waste releases (or their prevention) from (chemical) industry activities, taking local conditions into account, thereby improving the integrated performance of a chemical site. It enables the operator to:

- gain insight into the pollution-generating mechanisms of the production processes
- make balanced decisions about environmental measures
- avoid temporary solutions and no-return investments
- act adequately and proactively on new environmental developments.

An **environmental management system** (Section 2.1) normally follows a continuous loop process, the various steps supported by a number of management and engineering tools (Section 2.2), which are roughly categorised as:

- **inventory tools** providing, as a starting point, detailed and transparent information for the necessary decisions on waste prevention, minimisation and control. They include:
    - site inventory, giving detailed information on the location, the production processes and the respective plants, the existing sewerage system, etc.
    - stream (waste water and waste gas) inventory, giving detailed information on the waste streams (amount, pollutant content, their variability, etc.), their sources, quantification, evaluation and validation of the causes of emissions, ending in a ranking of the various streams to identify options and a priority listing for future improvements. A Whole Effluent Assessment and an assessment of the reduction of water usage and waste water discharge are also parts of a stream inventory
    - energy and material flow analysis, which aims to improve the operating efficiency of processes (as regards consumption of energy, raw material, waste release)

- **operational tools** for turning environmental management decisions into action. They include:
  - monitoring and regular maintenance
  - setting and regular review of internal targets or programmes for continuous environmental improvement
  - choice of treatment options and collection systems, based on the result of, e.g., inventory tools, and their implementation
  - quality control methods, used as 'trouble shooters' when an existing treatment process runs out of control or cannot fulfil set requirements. Such methods are, e.g., cause-effect diagram, Pareto analysis, flow diagram or statistical process control
- **strategic tools**, comprising the organisation and operation of waste handling on the entire chemical site in an integrated manner, evaluating environmental and economic options. They include:
  - risk assessment as a common methodology to calculate human and ecological risk as a result of activities of production processes
  - benchmarking as a process of comparison of the achievements of one plant or site with those of others
  - life cycle assessment as a process of comparison of the potential environmental effects of different ways of operating
- **safety and emergency tools**, necessary in the case of unplanned events such as accidents, fires or spillages.

TREATMENT TECHNIQUES (CHAPTER 3)

The techniques identified by the Technical Working Group and described in this document are those that are common in the chemical sector as a whole. They are introduced in a logical order, which follows the pollutant path.

The described WASTE WATER treatment techniques are:

- **separation or clarification techniques**, which are mainly used in combination with other operations, either as a first step (to protect other treatment facilities against damage, clogging or fouling by solids) or a final clarification step (to remove solids or oil formed during a preceding treatment operation):
  - grit separation
  - sedimentation
  - air flotation
  - filtration
  - microfiltration / ultrafiltration
  - oil-water separation

- **physico-chemical treatment techniques** for non-biodegradable waste water, mainly used for inorganic or hardly biodegradable (or inhibitory) organic contaminants, often as a pretreatment upstream of a biological (central) waste water treatment plant:
  - precipitation/sedimentation/filtration
  - crystallisation
  - chemical oxidation
  - wet air oxidation
  - super-critical water oxidation
  - chemical reduction
  - hydrolysis
  - nanofiltration / reverse osmosis
  - adsorption
  - ion exchange

- extraction
- distillation / rectification
- evaporation
- stripping
- incineration

- **biological treatment techniques** for biodegradable waste water:
  - anaerobic digestion processes, such as anaerobic contact process, UASB process, fixed-bed process, expanded-bed process, biological removal of sulphur compounds and heavy metals
  - aerobic digestion processes, such as complete-mix activated sludge process, membrane bioreactor process, trickling filter process, expanded-bed process, biofilter fixed-bed process
  - nitrification / denitrification
  - central biological waste water treatment.

The described WASTE WATER SLUDGE treatment techniques can be seen as single options or as a combination of single options. The following list is by no means intended to indicate a ranking. The availability (or non-availability) of a disposal route, however, can be a strong driver, at least at a local level, in the choice of an appropriate waste water control technique. The described waste water sludge treatment techniques are:

- preliminary operations
- sludge thickening operations
- sludge stabilisation
- sludge conditioning
- sludge dewatering techniques
- drying operations
- thermal sludge oxidation
- landfilling of sludge on site.

The described WASTE GAS treatment techniques cannot simply be classified as recovery or abatement techniques. Whether contaminants are recovered depends on the application of additional separation stages. Some of the techniques can be used as individual final operations, others only as a pretreatment or final polishing step. Most waste gas control techniques require further downstream treatment for either waste water or waste gas generated during the treatment process. The techniques are:

- **for VOC and inorganic compounds**:
  - membrane separation
  - condensation
  - adsorption
  - wet scrubbing
  - biofiltration
  - bioscrubbing
  - biotrickling
  - thermal oxidation
  - catalytic oxidation
  - flaring

- **for particulate matter**:
  - separator
  - cyclone
  - electrostatic precipitator
  - wet dust scrubber
  - fabric filter
  - catalytic filtration
  - two-stage dust filter
  - absolute filter (HEPA filter)
  - high-efficiency air filter (HEAF)
  - mist filter

- **for gaseous pollutants in combustion exhaust gases**:
  - dry sorbent injection
  - semi-dry sorbent injection
  - wet sorbent injection
  - selective non-catalytic reduction of NO_x (SNCR)
  - selective catalytic reduction of NO_x (SCR).

CONCLUSIONS ON BEST AVAILABLE TECHNIQUES (CHAPTER 4)

The chemical industry covers a wide range of enterprises: at one end the one-process-few-products small enterprises with one or few waste release sources and, at the other, the multi-production-mix enterprises with many complex waste streams. Although there are probably no two chemical sites that are totally comparable in production range and mix, environmental situation and the quantity and quality of their waste emissions is it possible to describe BAT for waste water and waste gas treatment for the chemical sector as a whole.

The implementation of BAT in new plants is not normally a problem. In most cases it makes economic sense to plan production processes and their waste releases to minimise emissions and material consumption. With existing sites, however, the implementation of BAT is not generally an easy task, because of the existing infrastructure and local circumstances. Nevertheless, this document does not distinguish between BAT for new and existing installations. Such a distinction would not help to improve the environmental situation of industrial sites towards adopting BAT and it would not reflect the commitment of the chemical industry to continuous improvement of environmental conditions.

❑ <u>Management</u>

As the detailed description of environmental management in Chapter 2 indicates, the prerequisite of good environmental performance is an Environmental Management System (EMS). In the final analysis, the proper and consistent execution of a recognised EMS will lead to the optimum environmental performance of a chemical industry site, thus achieving BAT.

On this premise, it is BAT to implement and adhere to an EMS that could include:

- implementation of a transparent hierarchy of personnel responsibility, the persons in charge reporting directly to the top management level
- preparation and publication of an annual environmental performance report
- setting internal (site- or company-specific) environmental targets, reviewing them regularly and publishing them in the annual report
- holding a regular audit to secure compliance with the principles of EMS
- regular monitoring of performance and progress towards the achievement of EMS policy

- practising risk assessment on a continuous basis to identify hazards
- practising benchmarking on a continuous basis and challenging the processes (production and waste treatment) on their water and energy consumption, waste generation and cross-media effects
- implementation of an adequate training programme for staff and instructions for contractors working on the site on Health, Safety and Environment (HSE) and emergency issues
- application of good maintenance practices.

It is further BAT to implement a waste water / waste gas management system (or waste water / waste gas assessment), as a subsystem to the EMS, using an appropriate combination of:

- site inventory and stream inventory
- checking and identifying the most relevant emission sources for each medium and listing them according to their pollutant load
- checking the receiving media (air and water) and their tolerance of the emissions, using the results to determine the extent to which stronger treatment requirements are needed or if the emissions can be accepted at all
- performing assessment of toxicity, persistence and potential bioaccumulation of waste water to be discharged into a receiving water body and sharing the results with the competent authorities
- checking and identifying relevant water-consuming processes and listing them according to their water usage
- pursuing options for improvement, focusing on streams with higher concentrations and loads, their hazard potential and impact on the receiving water body [1]
- assessing the most effective options by comparing overall removal efficiencies, overall balance of cross-media effects, technical, organisational and economic feasibility etc.

Further BAT are to:

- assess impact on the environment and the effects on treatment facilities when planning new activities or alterations to existing activities
- practise emission reduction at source
- link production data with the data on emission loads to compare the actual and calculated releases
- treat contaminated waste streams at source in preference to dispersion and subsequent central treatment, unless there are good reasons against it
- use quality control methods to assess the treatment and/or production processes and/or prevent them running out of control
- apply good manufacturing practice (GMP) for equipment cleaning to reduce emissions to water and to air
- implement facilities / procedures to enable timely detection of a deviation that could affect the downstream treatment facilities, so as to avoid an upset of those treatment facilities
- install an efficient central warning system that will give notice of failures and malfunctions to all concerned
- implement a monitoring programme in all waste treatment facilities to check that they are operating properly
- put in place strategies for dealing with fire-fighting water and spillages
- put in place a pollution incident response plan
- allocate costs of waste water and waste gas treatment associated with production.

Process-integrated measures are not within the scope of the document, but they are an important means of optimizing environmental performance of production processes. Thus, it is BAT to:

[1] One Member State wants a more precise definition of 'streams with higher concentration' that includes values for loads and/or concentrations. A split view is reported. Further details are given in Chapter 4.

- use process-integrated measures in preference to end-of-pipe techniques when there is a choice
- assess existing production installations for options of retrofitting process-integrated measures and implement them when feasible or at latest when the installation undergoes major alterations.

Waste Water

An adequate WASTE WATER COLLECTION SYSTEM plays an essential role in effective waste water reduction and/or treatment. It ducts the waste water streams to their appropriate treatment device and prevents mixing of contaminated and uncontaminated waste water. Thus, BAT is to:

- segregate process water from uncontaminated rainwater and other uncontaminated water releases. If existing sites do not yet operate water segregation, it can be installed – at least partially – when major alterations are made to the site
- segregate process water according to its contamination load
- install a roof over areas of potential contamination wherever feasible
- install separate drainage for areas of contamination risk, including a sump to catch leakage or spillage losses
- use overground sewers for process water inside the industrial site between the points of waste water generation and the final treatment device(s). If climatic conditions do not allow overground sewers (temperatures significantly below 0 °C), systems in accessible underground ducts are a suitable replacement. Many chemical industry sites are still provided with underground sewers and the immediate construction of new sewer systems is normally not viable, but work can be done in stages when major alterations to production plants or the sewer system are planned
- install retention capacity for failure events and fire-fighting water in the light of a risk assessment.

WASTE WATER TREATMENT in the chemical sector follows at least four different strategies:

- central final treatment in a biological WWTP on site
- central final treatment in a municipal WWTP
- central final treatment of inorganic waste water in a chemical-mechanical WWTP
- decentralised treatment(s).

None of these four is preferred to the others, as long as an equivalent emission level is guaranteed for the protection of the environment as a whole and provided this does not lead to higher levels of pollution in the environment [Article 2(6) of the Directive].

It is assumed at this stage that the appropriate effluent management decisions have been made, the impact on the receiving water body has been assessed, all practical options for prevention and reduction of waste water have been exploited and all safety measures have been taken into account, i.e. from this point on, only end-of-pipe solutions are considered.

For **rainwater**, it is BAT to:

- duct uncontaminated rainwater directly to a receiving water, by-passing the waste water sewerage system
- treat rainwater from contaminated areas before discharging it into a receiving water.

In some cases the use of rainwater as process water to reduce fresh water consumption may be environmentally beneficial.

Appropriate treatment facilities are:

- grit chamber
- retention pond
- sedimentation tank
- sand filter.

It is BAT to remove **oil and/or hydrocarbons** when they appear as large slugs or where they are incompatible with other systems, with the aim of maximising recovery, by applying an appropriate combination of:

- oil/water separation by cyclone, microfiltration or API (American Petroleum Institute) separator, when large slugs of free oil or hydrocarbons can be expected, otherwise the parallel plate interceptor and the corrugated plate interceptor are alternatives
- microfiltration, granular media filtration or gas flotation
- biological treatment.

BAT-associated emission levels	
Parameter	**Concentration [a] [mg/l]**
total hydrocarbon content [b]	0.05-1.5
BOD_5	2-20
COD	30-125

[a] monthly average
[b] There is disagreement on the analytical methods to assess hydrocarbons which could not be solved within the TWG.

It is BAT to break and/or remove **emulsions** at source.

For **suspended solids (TSS)** (TSS that include heavy metal compounds or activated sludge need other measures), it is BAT to remove them from waste water streams when they could cause damage or failure to downstream facilities or before they are discharged into a receiving water. Common techniques are:

- sedimentation / air flotation to catch the main TSS load
- mechanical filtration for further solids reduction
- microfiltration or ultrafiltration when solid-free waste water is required.

Techniques that enable recovery of substances are preferred.

It is further BAT to

- control odour and noise by covering or closing the equipment and ducting the exhaust air to further waste gas treatment if necessary
- dispose of the sludge, either by handing it to a licensed contractor or by treating it on site (see section on sludge treatment).

As **heavy metals** are chemical elements that cannot be destroyed, recovery and re-use are the only ways to prevent them being released into the environment. Any other option causes them to be transferred between the different media: waste water, waste air and landfilling.

Thus, for heavy metals, it is BAT to do **all** of the following:

- segregate waste water containing heavy metal compounds as far as possible and
- treat the segregated waste water streams at source before mixing with other streams and
- use techniques that enable recovery as widely as possible and
- facilitate further elimination of heavy metals in a final WWTP as a polishing step, with subsequent treatment of sludge, if necessary.

The appropriate techniques are:

- precipitation / sedimentation (or air flotation instead) / filtration (or microfiltration or ultrafiltration instead)
- crystallisation
- ion exchange
- nanofiltration (or reverse osmosis instead).

Because the emission levels that can be achieved by these control techniques are strongly dependent on the source process from which the heavy metals are released, the TWG found themselves unable to identify BAT-associated emission levels that would be valid for the chemical sector as a whole. It was recommended that this subject be dealt with in the appropriate process BREFs.

The **inorganic salt (and/or acid) content** of waste water can influence both the biosphere of a receiving water, e.g. small rivers when they are confronted with high salt loads, and the operation of sewerage systems, e.g. corrosion of pipes, valves and pumps or malfunction of downstream biological treatment. In the case of one or both of these possibilities, it is BAT to control the inorganic salt content, preferably at source and preferably with control techniques that enable recovery. Appropriate treatment techniques (not including techniques for treating heavy metals or ammonium salts) are:

- evaporation
- ion exchange
- reverse osmosis
- biological sulphate removal (used only for sulphate, but when heavy metals are present, they are also removed).

Pollutants unsuitable for biological treatment are, e.g. recalcitrant TOC and/or toxic substances that inhibit the biological process. Thus their discharge into a biological treatment plant needs to be prevented. It is not possible to forecast which contaminants are inhibitors for biological processes in a WWTP, because this depends on the adaptation to special contaminants of the micro-organisms working in the particular plant. Thus, it is BAT to avoid the introduction of waste water components into biological treatment systems when they could cause a malfunction of such systems and to treat tributary waste water streams with relevant non-biodegradable part by adequate techniques.[2]

- choice 1: techniques that enable substance recovery:
  - nanofiltration or reverse osmosis
  - adsorption
  - extraction
  - distillation / rectification
  - evaporation
  - stripping
- choice 2: abatement techniques without need of additional fuel, when recovery is not feasible:
  - chemical oxidation, but care must be taken with chlorine-containing agents
  - chemical reduction
  - chemical hydrolysis
- choice 3: abatement techniques entailing considerable energy consumption, when there is no other choice to abate toxicity or inhibitory effects or when the process can be operated on a self-sustaining basis:
  - wet air oxidation (low-pressure or high-pressure variant)
  - waste water incineration
- in cases where water supply and consumption is an environmental issue, techniques requiring considerable amounts of cooling water or wet scrubber systems for exhaust air treatment need to be assessed, such as:
  - extraction
  - distillation / rectification
  - evaporation
  - stripping.

Biodegradable waste water can be treated in biological control systems, either as tributary streams in specially designed (pre)treatment systems, e.g. anaerobic or aerobic high load systems, or as mixed waste water in a central biological waste water treatment plant, or as a polishing step behind the central waste water treatment plant. Thus, it is BAT to remove biodegradable substances by using an appropriate biological treatment system (or an appropriate combination of them), such as:

- biological pretreatment to relieve the final central biological waste water treatment plant from high biodegradable load (or as a final polishing step). Appropriate techniques are:
  - anaerobic contact process
  - upflow anaerobic sludge blanket process
  - anaerobic and aerobic fixed-bed process
  - anaerobic expanded-bed process
  - complete-mix activated sludge process
  - membrane bioreactor
  - trickling (percolating) filter
  - biofilter fixed-bed process
- nitrification / denitrification when the waste water contains a relevant nitrogen load
- central biological treatment, avoiding the introduction of non-biodegradable waste water pollutants, when they can cause malfunction of the treatment system and when the plant is not suitable to treat them. In general the BAT-associated emission level for BOD after central biological treatment is < 20 mg/l. In the case of activated sludge a typical application is a low-loaded biological stage with a daily COD load of ≤ 0.25 kg/kg sludge.

[2] One Member States insists on a more close definition of the criterion 'relevant non-biodegradable part'. A split view is reported. Details in Chapter 4.

BAT-associated emission levels for the final discharge into a receiving water body [3]:		
Parameter [a]	**Performance rates [%]**	**Emission levels [mg/l] [b]**
TSS		10-20 [c]
COD	76-96 [d]	30–250
total inorganic N [e]		5-25
total P		0.5-1.5 [f]
AOX		

[a] for BOD see preceding section on central biological treatment
[b] daily average, exception TSS
[c] monthly average
[d] low performance rates for low contaminant concentrations
[e] sum of NH_4-N, NO_2-N and NO_3-N (a more recommendable parameter would be total N. Because of the lack of information on total N, total inorganic N is used here)
[f] lower range from nutrient feed in biological WWTP, upper range from production processes

Waste Water Sludge

When waste water sludge is handled on the chemical industry site it is BAT to use one or several of the following options (without preference):

- preliminary operations
- sludge thickening operations
- sludge stabilisation
- sludge conditioning
- sludge dewatering techniques
- drying operations
- thermal sludge oxidation
- landfilling of sludge on site.

Off-site treatment is not taken into account because it is not within the scope of the document. This is by no means a BAT conclusion against off-site treatment by third-party contractors.

Waste Gas

WASTE GAS COLLECTION SYSTEMS are installed to route gaseous emissions to treatment systems. They consist of the emission source enclosure, vents and pipes. It is BAT to:

- minimise the gas flow rate to the control unit by encasing the emission sources as far as feasible
- prevent explosion risk by:
  - installing a flammability detector inside the collection system when the risk of occurrence of a flammable mixture is significant
  - keeping the gas mixture securely below the lower explosion limit or above the higher explosion limit
- install appropriate equipment to prevent the ignition of flammable gas-oxygen mixtures or minimise its effects.

[3] One Member State insists on also including BAT-associated emission levels for AOX and heavy metals at the final discharge point. A split view is reported. Details of the state of discussion are given in Chapter 4.

The sources of waste gases are distinguished in this document as:

- low-temperature sources, such as production processes, handling of chemicals, work-up of products
- high-temperature sources, such as combustion processes, which include facilities such as boilers, power plants, process incinerators and thermal and catalytic oxidisers.

Low-temperature sources

Pollutants to be controlled in waste gases released from low-temperature sources (production process gases) are dust (particulate matter), VOCs and inorganic compounds (HCl, SO_2, NO_x etc.).

It is BAT to remove **dust/particulate matter** from waste gas streams, either as final treatment or as pretreatment to protect downstream facilities, using material recovery whenever it is feasible. The energy and water consumption of treatment techniques needs to be borne in mind. Appropriate control techniques are:

- pretreatment techniques with potential recovery:
  - separator
  - cyclone
  - mist filter (also as polishing filter for aerosols and droplets)
- final treatment techniques
  - wet scrubber
  - electrostatic precipitator
  - fabric filter
  - various high efficiency filters, dependent on kind of particulate matter.

It is BAT to remove **VOCs** from waste gas streams. The control technique to apply depends strongly on the process from which they are released and the degree of hazard they represent.

- choice 1: techniques to recover raw material and/or solvents, often applied as pretreatment to recover the main VOC load before downstream abatement facilities or to protect downstream facilities as a safety issue. Appropriate techniques are:
  - wet scrubbing
  - condensation
  - membrane separation
  - adsorption

  or combinations thereof:
  -condensation / adsorption
  -membrane separation / condensation

- choice 2: abatement techniques when recovery is not feasible, giving preference to low-energy techniques

- choice 3: combustion techniques (thermal or catalytic oxidation), when other equally efficient techniques are not available.

When combustion techniques are applied, it is BAT to implement combustion exhaust gas treatment when considerable amounts of exhaust gas contaminants are to be expected.
It is further BAT to use flaring only to dispose safely of surplus combustible gases from, e.g. maintenance events, upset systems or remote vents not connected to abatement systems.

For **other compounds than VOCs**, it is BAT to remove these pollutants, applying the appropriate technique:

- wet scrubbing (water, acidic or alkaline solution) for hydrogen halides, Cl_2, SO_2, H_2S, NH_3
- scrubbing with non-aqueous solvent for CS_2, COS
- adsorption for CS_2, COS, Hg
- biological gas treatment for NH_3, H_2S, CS_2
- incineration for H_2S, CS_2, COS, HCN, CO
- SNCR or SCR for NO_x.

When feasible, recovery techniques are preferred to abatement techniques, e.g.:

- recovery of hydrogen chloride when using water as scrubbing medium in the first scrubbing stage to produce a solution of hydrochloric acid
- recovery of NH_3.

The TWG has not been able to come to a conclusion on BAT-associated emission levels for waste gases from production processes that would apply to the chemical industry as a whole. BAT-associated emission levels for process gases are strongly dependent on the actual production process and it was recommended to deal with this subject in the appropriate process BREFs.

High-temperature sources

Pollutants to be controlled in waste gases from high-temperature processes (combustion exhaust gases) are dust (particulate matter), halogen compounds, carbon monoxides, sulphur oxides, NO_x and possibly dioxins.

It is BAT to remove **dust / particulate matter** by the implementation of one of the following:

- electrostatic precipitator
- bag filter (after heat exchanger at 120-150 °C)
- catalytic filter (comparable conditions as bag filter)
- wet scrubbing.

It is BAT to recover **HCl, HF and SO_2** by using two stage wet scrubbing or to remove them by dry, semi-dry or wet sorption injection, although wet scrubbing is normally the most efficient technique for abatement as well as for recovery.

For **NO_x**, it is BAT to implement SCR instead of SCNR (at least for larger installations) because it has better removal efficiency and environmental performance. For existing installations which operate SNCR devices, the time to consider changing might be when major alterations are planned for the incineration plant. Although SCR is BAT in the general sense, there are individual cases (typically smaller installations) where SNCR is the technically and economically best solution. Other measures need to be assessed for their ability to deliver greater overall improvement than retrofitting SNCR.

BAT-associated emission levels of combustion exhaust gas treatment	
Parameter	**Emission levels [mg/Nm^3] [1]**
dust	<5-15
HCl	<10
HF	<1
SO_2	<40-150 [2]
NO_x (gas boilers/heaters)	20-150 [3]
NO_x (liquid boilers/heaters)	55-300 [3]
NH_3 [4]	<5 [5]
dioxins	0.1 ng/Nm^3 TEQ

[1] ½ hourly average, reference oxygen content 3 %
[2] lower range for gaseous fuel, upper range for liquid fuel
[3] higher value for small installations using SNCR
[4] NH_3 slip with SCR
[5] value for new catalysts, but higher NH_3 emissions occur as the catalyst ages

CONCLUDING REMARKS AND RECOMMENDATIONS (CHAPTER 6)

There were four split views expressed by one Member State following the second TWG meeting.

1. they expressed the opinion that the statements on BAT for waste water and waste gas management are partly too general and they refer to examples for streams with higher concentrations and loads (as mentioned in Section 2.2.2.3.1).
2. they expressed a view that the criterion 'relevant non-biodegradable part' needs to be more closely defined by giving a set of indicative values for recalcitrant TOC to waste water streams.
3. they insist on naming BAT-associated emission levels for heavy metals based on the examples given in Annex 7.6.4. In their view, when following the strategy of prevention, pretreatment and central treatment as outlined above (see section on heavy metals), it is possible to name BAT-associated emission values for heavy metals which are valid for many chemical sites. They further state that the values are influenced by the portion of productions relevant to heavy metals and hence are dependent on the production mix, which can cause higher values in special cases, especially in fine chemicals production. With regard to releases into public sewerage systems, the effect of the WWTP would have to be taken into account in so far as it would be ensured that the heavy metals are not shifted to other media.
   The TWG did not follow this request, stating that it would not be useful to name BAT-associated emission levels which are influenced by particular combinations of waste water streams on individual production sites, resulting in values which might or might not be valid in real-life cases. A split view is therefore recorded.

4. they insist on naming BAT-associated emission levels for AOX based on the examples given in Annex 7.6.2. They state that BAT-associated emission levels can be given, although the emission values for AOX are strongly influenced by the portion and kind of chlororganic syntheses on a chemical site, when waste water treatment is operated according to the BAT-conclusions given above (see section on pollutants unsuitable for biological treatment).
   The TWG did not follow this request. The examples presented (see Annex 7.6.2) were interpreted as consisting of different statistical data sets which did not allow naming BAT-associated emission levels. It was even mentioned that one of the lowest AOX emission levles reported as examples represented poor performance, whereas the highest emission level within the data set came from a site with very good performance. Under these conditions the TWG saw it to be unsuitable to give BAT-associated emission levels for AOX. A split view is therefore recorded.

The exchange of information itself has been considerably less than complete. It is difficult to understand why this should have been so, given the chemical industry's past efforts and achievements in the management of waste water and waste gas releases. Equally difficult was the exchange of information with a number of Member States.

As to reviewing the BREF, the recommendation is to fill the existing gaps. The review should wait until all the vertical BREFs in the chemical sector are finalised. For such a review to make sense, however, it will be necessary to focus more on the information that is useful for a permit writer. Further detail can be found in Chapter 6.

The EC is launching and supporting, through its RTD programmes, a series of projects dealing with clean technologies, emerging effluent treatment and recycling technologies and management strategies. Potentially these projects could provide a useful contribution to future BREF reviews. Readers are therefore invited to inform the EIPPCB of any research results which are relevant to the scope of this document (see also the preface of this document).