Sector Guidance Note IPPC S6.10

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Guidance for the Food and Drink Sector

ENVIRONMENT AND HERITAGE SERVICE

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Table 0.1: Record of changes

Version	Date	Change	Template Version
Consultation	August 2001	Initial draft issue	V1
Consultation	October 2001	Draft issued for external consultation	V3
Final	November 2002	Amendments from consultation	V2.01
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Executive summary

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

What is IPPC

Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. It involves determining the appropriate controls for industry to protect the environment through a single Permitting process. To gain a Permit, Operators will have to show that they have systematically developed proposals to apply the Best Available Techniques (BAT) and meet certain other requirements, taking account of relevant local factors.

This Guidance and the BREF

This Sector is due to be brought into IPPC (PPC) Regulations at a later date. This document is the interim UK guidance for delivering the PPC Regulations in this sector for the period leading up to the production of the BAT Reference document BREF produced by the European Commission. The BREF will be a result of an exchange of information between member states and industry. The quality, comprehensiveness and usefulness of the BREF system is acknowledged and subsequent versions of this guidance will complement the BREF and be cross referenced to it throughout and will take into account the information contained in the BREF. In the meantime it lays down the standards and expectations in the UK (England and Wales, Scotland and Northern Ireland) for the techniques and standards that need to be addressed to satisfy the Regulations.

The aims of this Guidance

The aims of this Guidance are to:

provide a clear structure and methodology for Operators to follow to ensure they address all aspects of the PPC Regulations and other relevant Regulations
minimise the effort by both Operator and Regulator in the permitting of an installation by expressing the BAT techniques as clear indicative standards
improve the consistency of applications by ensuring that all relevant issues are addressed
increase the transparency and consistency of regulation by having a structure in which the Operator's response to each issue, and any departures from the standards, can be seen clearly and which enables applications to be compared

To assist Operators in making applications, separate, horizontal guidance is available on a range of topics such as waste minimisation, monitoring, calculating stack heights and so on. Most of this guidance is available free through the Environment Agency, SEPA or EHS (Northern Ireland) websites (see **References**).

key environmental issues

The key environmental issues for this sector are:

- Waste minimisation
- Water use
- Releases associated with energy use
- Emissions to air
- Effluent management
- Accident risk
- Hygiene and food safety

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1 Introduction

The status and aims of this Guidance

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

It aims to provide Operators and the Regulator's officers with advice on indicative standards of operation and environmental performance relevant to the industrial sector concerned, to assist the former in the preparation of applications for PPC Permits and to assist the latter in the assessment of those Applications (and the setting of a subsequent compliance regime). The use of techniques quoted in the guidance and the setting of emission limit values at the benchmark values quoted in the guidance are not mandatory, except where there are statutory requirements from other legislation. However, the Regulator will carefully consider the relevance and relative importance of the information in the Guidance to the installation concerned when making technical judgments about the installation and when setting Conditions in the Permit, any departures from indicative standards being justified on a site-specific basis.

The Guidance also aims (through linkage with the Application Form or template) to provide a clear structure and methodology for Operators to follow to ensure they address all aspects of the PPC Regulations and other relevant Regulations, that are in force at the time of writing. Also, by expressing the Best Available Techniques (BAT) as clear indicative standards wherever possible, it aims to minimise the effort required by both Operator and Regulator to apply for and issue, respectively, a Permit for an installation.

1.1 Understanding IPPC

IPPC and the Regulations

Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. It involves determining the appropriate controls for industry to protect the environment through a single permitting process. To gain a Permit, Operators will have to show that they have systematically developed proposals to apply the Best Available Techniques (BAT) and meet certain other requirements, taking account of relevant local factors.

The essence of BAT is that the selection of techniques to protect the environment should achieve an appropriate balance between the environmental benefits and the costs incurred by Operators.

IPPC operates under the Pollution Prevention and Control Regulations, (see **The Pollution Prevention and Control Regulations** and **Appendix 2**). These Regulations have been made under the Pollution Prevention and Control (PPC) Act 1999 and implement the EC Directive 96/61 on IPPC. Further information on the overall system of IPPC, together with Government policy and more detailed advice on the interpretation of the Regulations, can be found in the Department of the Environment, Food and Rural Affairs (DEFRA) document **IPPC: A Practical Guide**.

Installation based, NOT national emission limits

The BAT approach of IPPC differs from regulatory approaches based on fixed national emission limits (except where General Binding Rules or standard Permits are issued). The legal instrument that ultimately defines BAT is the Permit, and this can only be issued at the installation level.

Indicative BAT Standards

Indicative BAT standards (essentially for BAT, but also covering other aspects) are laid out in national guidance (such as this) and should be applied unless there is strong justification for another course of action. BAT includes both the technical components of the installation given in Section 2 and the benchmark levels identified in Section 3. Departures from those standards, in either direction, can be justified at the local level taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. If there are any applicable mandatory EU emission limits, these must be met, although BAT may go further.

BAT and EQS

The BAT approach also differs from, but complements, regulatory approaches based on Environmental Quality Standards (EQS). Essentially, BAT requires measures to be taken to prevent or, where this is not practicable, to reduce emissions. That is, if emissions can be reduced further, or prevented altogether, at reasonable cost, then this should be done irrespective of whether any environmental quality standards are already being met. It requires us not to consider the environment as a recipient of pollutants and waste, which can be filled up to a given level, but to do all that is practicable to minimise the impact of industrial activities. The BAT process considers what can be reasonably achieved within the installation first (covered by Sections 2 and 3 of this Guidance) and only then checks to ensure that the local environmental conditions are secure (see **Section 4** on page 122 of this Guidance and **IPPC Environmental Assessments for BAT**). So the BAT approach is a more precautionary one, which may go beyond the requirements of Environmental Quality Standards.

Conversely, it is possible that the application of BAT may lead to a situation in which an EQS is still threatened. The Regulations therefore allow for expenditure beyond indicative BAT where necessary. This situation should arise very rarely assuming that the EQS is soundly based on an assessment of harm. The BAT assessment, which balances cost against benefit (or prevention of harm) should, in most cases, have come to the same conclusion about the expenditure which is appropriate to protect the environment.

Advice on the relationship of environmental quality standards and other standards and obligations is given in **IPPC: A Practical Guide** and in Section 3.

Assessing BAT at the sector level

The assessment of BAT takes place at a number of levels. At the European level, the EC issues a BAT reference document (BREF) for each sector. The BREF is the result of an exchange of information which member states should take into account when determining BAT, but which gives them flexibility in its application. This UK Sector Guidance Note takes into account the information contained in the BREF and lays down the indicative standards and expectations in the UK. At this national level, techniques that are considered to be BAT should represent an appropriate balance of costs and benefits for a typical, well-performing installation in that sector and be affordable without making the sector as a whole uncompetitive, either within Europe or world-wide.

Assessing BAT at the installation level

When assessing which sectoral, indicative BAT standards apply at the installation level, departures may be justified in either direction as described above. The most appropriate technique may depend on local factors and, where the answer is not self-evident, a local assessment of the costs and benefits of the available options may be needed. Individual company profitability is not considered. Further information on this can be found in **IPPC: A Practical Guide** and **IPPC Part A(1) Installations: Guide for Applicants**.

Costs may only be taken into account at the local level where:

- the local technical characteristics or environmental conditions can be shown to be different from those assumed in the national/European assessment of BAT described in this guidance; in such cases a local cost benefit assessment may be appropriate
- where the BAT cost/benefit balance of an improvement only becomes favourable when the relevant item of plant is due for renewal/renovation. In effect, these are cases where BAT for the sector can be expressed in terms of local investment cycles
- a number of expensive improvements are needed. Then a phasing programme may be appropriate as long as it is not so drawn out that it appears to be rewarding a poorly performing installation, (see **IPPC Environmental Assessments for BAT** for more details).

Innovation

The Regulators encourage the development and introduction of innovative techniques that meet the BAT criteria. They are looking for continuous improvement in the overall environmental performance of the installation as a part of progressive sustainable development. This Sector Guidance Note describes the indicative standards at the time of writing. However, Operators should keep up-to-date with the relevant BATs. This note may not be cited in an attempt to delay introducing improved techniques. The technical characteristics of a particular installation may also allow for opportunities not foreseen in the Guidance; as BAT is determined at the installation level, except in the case of General Binding Rules (GBRs), it is valid to consider these even where they go beyond the Indicative Standards.

New installations

The Indicative Requirements apply to both new and existing activities, but it will be more difficult to justify departures from them in the case of new installations. For new activities the Indicative Requirements should normally be in place before operations start. In some cases, such as where an audit of ongoing operations is required, this is not possible and indicative upgrading timescales are given for such cases.

Existing installation standards

For upgrading timescales for existing plant, see **Section 1.4.2** on page 6.

1.2 Making an application

A satisfactory Application is made by:

- addressing the issues in Sections 2 and 3 of this guidance;
- assessing the environmental impact described in Section 4 (and in England and Wales **Environmental Assessment and Appraisal of BAT (IPPC H1)**);
- demonstrating that the proposed techniques are BAT for the installation.

In practice, some Applicants have submitted far more information than was needed, yet without addressing the areas that are most important - and this has led to extensive requests for further information. In an attempt to focus application responses to the areas of concern to the Regulator, Application forms (templates) have been produced by the Environment Agency, by SEPA and by EHS in N Ireland. In addition, as the dates for application have approached, the operators in most industrial sectors in England and Wales have been provided with Compact Discs (CDs) which contain all relevant Application Forms, technical and administrative guidance, BREFs and Assessment tools, hyper-linked together for ease of use.

For Applicants with existing IPC Authorisations or Waste Management Licences, the previous applications may provide much of the information for the PPC application. However, where the submitted Application refers to information supplied with a previous application the Operator will need to send fresh copies - though for many issues where there is a tendency for frequent changes of detail (for example, information about the management systems), it will be more appropriate simply to refer to the information in the Application and keep available for inspection on site, up-to-date versions of the documents.

For further advice see **IPPC Part A(1) Installations: Guide for Applicants (for England and Wales)** or **PPC Part A Installations: Guide for Applicants (for Scotland)** or the equivalent Northern Ireland guide for Applicants.

1.3 Installations covered

This Guidance relates to installations containing the activities listed below, as described in Part A(1) of Schedule 1 to the **The Pollution Prevention and Control Regulations**. The schedules of listed activities are slightly different in Scotland and Northern Ireland so for their equivalent Regulations see **Appendix 2**

Section 6.8

(d) Treating and processing materials intended for the production of food products from –

(i) animal raw materials (other than milk) at plant with a finished product production capacity greater than 75 tonnes per day

(ii) vegetable raw materials at plant with a finished product production capacity greater than 300 tonnes per day (average value on a quarterly basis)

(e) Treating and processing milk, the quantity of milk received being greater than 200 tonnes per day (average value on an annual basis).

The installation will also include **associated activities** which have a technical connection with the main activities and which may have an effect on emissions and pollution, as well as the main activities described above. These may involve activities such as:

- the storage and handling of raw materials;
- the storage and despatch of finished products, waste and other materials;
- the control and abatement systems for emissions to all media;
- waste treatment or recycling.
- washing
- mixing and blending
- heating and cooking
- drying
- cleaning
- the power plant

Environment Agency advice on the composition of English or Welsh installations and which on-site activities are to be included within it (or them) is given in its guidance document **IPPC Part A(1) Installations: Guide for (Applicants England and Wales) (includes Preparation of a Site Report in a Permit Application) (EA website).**. Operators are advised to discuss the composition of their installations with the Regulator before preparing their Applications.

1.4 Timescales

1.4.1 Permit review periods

Permits are likely to be reviewed as follows:

- for individual activities not previously subject to regulation under IPC or Waste Management Licensing, a review should be carried out within four years of the issue of the PPC Permit
- for individual activities previously subject to regulation under IPC or Waste Management Licensing, a review should be carried out within six years of the issue of the IPPC Permit

However, where discharges of Groundwater List I or List II substances have been permitted, or where there is disposal of any matter that might lead to an indirect discharge of any Groundwater List I or II substance, a review must be carried out within four years as a requirement of the Groundwater Regulations.

These periods will be kept under review and, if any of the above factors change significantly, they may be shortened or extended.

1.4.2 Upgrading timescales for existing plant

Existing installation timescales

For an existing activity, a less strict proposal (or an extended timescale) may be acceptable, for example, where the activity already operates to a standard that is very close to an indicative requirement. Equally, local environmental impacts may require action to be taken more quickly than the indicative timescales given in this Guidance. Furthermore, where IPC upgrading programmes are already in place, it is not expected that the indicative timescales given in this Guidance would normally extend to these.

Upgrading timescales will be set in the improvement programme of the Permit, along the following lines. Improvements fall into a number of categories:

1 The many good-practice requirements in Section 2, such as management systems, waste, water and energy audits, bunding, good housekeeping measures to prevent fugitive or accidental emissions, energy baseline measures, waste-handling facilities, monitoring equipment, or installation of some secondary techniques. Also, longer-term studies required for control, environmental impacts and the like. All of the category 1 improvements should be comopleted within 3 years of the issue of the Permit.

2 The larger, usually more capital-intensive improvements such as abatement equipment.

3 Specific improvemements are shown in **Table 1.1**.

All improvements should be carried out at the earliest opportunity and to a programme approved by the Regulator. Any longer timescales will need to be justified by the Operator.

Table 1.1: Specific timescale improvements

Improvement	By whichever is the later of:	
	Activities under Section 6.8di (see Section 1.3) – Animal raw materials	Activities under Section 6.8dii and 6.8e (see Section 1.3) – Vegetable raw materials and milk
Waste minimisation audit in accordance with **Section 2.4.2** on page 75	31 August 2005 or one year from the issue of the Permit	31 March 2006 or one year from the issue of the Permit
A review of water use (water efficiency audit) in accordance with **Section 2.4.3** on page 78	31 August 2005 or one year from the issue of the Permit	31 March 2006 or one year from the issue of the Permit

The Applicant should include a proposed timetable covering all improvements.

1.5 Key issues

An assessment of the issues indicates that there are no areas where there is a fundamental clash between good environmental practice and good business practice. However, the implementation of pollution prevention and control measures represents a balance between environmental protection and will not always result in cost savings for the Operator.

The regulator would expect that the application of BAT would in particular enable operators to make improvements with respect to waste minimisation and water use.

Waste minimisation

Commercial considerations mean that the controls of parameters such as process yield and product wastage are usually understood. These parameters are also key pollution prevention issues as product loss accounts for a significant proportion of the sector's environmental impact.

Water use

The sector is a significant water consumer for process consumption, means of conveyance and cleaning. In addition to minimising the use of a raw material, measures to optimise water use will be important pollution prevention measures relating to effluent management. There are a number of opportunities to either re-use water (for example low-grade wash waters) or to recycle water from, for example, membrane systems (also see Hygiene and food safety below).

Releases associated with energy use

The industry is a major energy user. There remain significant opportunities for reduction of emissions caused by energy use and choice of energy source (CO_2, SO_x, NO_x, etc., contributing in particular to global warming and acidification). The industry has entered into a Climate Change Levy Agreement with the Government. The applicability of techniques and standards for IPPC is explained in **Section 2.6** on page 84.

Emissions to air

It is an inherent factor within many food and drink processes that emissions of volatile organic compounds (VOCs) and odour arise, for example, from cooking and drying processes. Emissions of dust and particulate can also be a factor from activities such as mixing, grinding, milling and transfer of materials. Odour emissions can be problematic, not only because of the sometimes subjective nature of the problem, but as emissions tend to be fugitive. Other fugitive emissions considerations include those potentially arising from refrigeration and cooling systems.

Effluent management

Other than the predominantly "dry" activities, for example milling, most food and drink processes generate wastewaters. The composition of the effluent is highly variable, dependent on the activity, working patterns, product wastage and cleaning systems. A critical issue is keeping raw materials, intermediates, product and by-product out of the wastewaters, by controlling product wastage and cleaning processes.

Accident risk

Many materials used by the sector have high oxygen demand, and spills and leaks into the water environment can be serious events. In addition to normal spills and process leaks, they typically arise from, for example, overfilling of vessels and failure of containment, wrong drainage connections and blocked drains.

Hygiene and food safety

Health and safety, and product quality issues apply to industry as a whole, but hygiene and food safety is of fundamental importance to the food and drink sector. Consequently particular attention must be given to these considerations when specifying particular techniques, especially in relation to pollution prevention measures, in, for example, measures relating to water use, cleaning and re-use and recycling of water. Industry experience of managing risk in relation to hygiene and food safety issues is a sound basis for environmental management issues.

1.6 Summary of releases

Table 1.2: Summary of releases

SOURCE → / RELEASES ↓	Storage and handling of raw materials	Cutting, sorting, peeling and washing	Mixing and blending (powders and solids)	Mixing, blending and homogenisation (solid/liquid)	Cooking, baking, roasting and frying	Pasteurisation and sterilisation	Solvent extraction	Drying and evaporation	Cleaning and sanitisation	Storage and dispatch of finished products	Cooling and refrigeration	Combustion plant	Effluent treatment plant (Note 1)
Oxides of sulphur	-	-	-	-	-	-	-	-	-	-	-	A	-
Oxides of nitrogen and carbon	-	-	-	-	A	-	-	-	-	-	-	A	-
Particulate/TSS	AW	W	AW	W	A	W	-	AW	AW	AW	-	A	W
COD/BOD	W	W	-	W	W	W	W	W	W	W	-	-	W
Odour	A	AW	W	A	A	AW	A	A	A	A	-	A	A
Biocides	W	W	-	-	-	-	-	-	W	-	-	-	W
Dispersants and surfactants	-	-	-	-	-	-	-	-	W	-	-	-	-
Phosphates and nitrates	-	-	-	-	-			-	W	-	-	-	-
Refrigerants: Ammonia, HCFC, Glycol	-	-	-		-	-	-	-	-	-	AW	-	W
Sludges	L	-	-		-			-	L	-	-	-	L
KEY	A – Release to Air, W – Release to Water, L – Release to Land												

Note:

1. Most of the other releases to water pass through the effluent treatment plant (ETP). Included here are only those which arise as a direct result of the operation of the ETP.

2. Releases to air usually result in a subsequent, indirect emission to land and can therefore affect human health, soil and terrestrial ecosystems.

3. Releases identified above to water can all also appear in the effluent treatment sludge (see **Section 2.5** on page 83).

1.7 Technical overview

Table 1.3: Breakdown of the main activities by Standard Industry Classification (SIC) code

SIC Code	Subsector	Aggregated subsector
15.11	Production and preserving of meat	Primary Meat Processing
15.11/1	Slaughtering of animals other than poultry and rabbits (not covered by this Guidance)	
15.11/2	Animal by-product processing (not covered by this Guidance)	
15.12	Production and preserving of poultry meat	
15.13	Production of meat and poultry meat products	Secondary Meat Processing
15.13/1	Bacon and ham production	
15.13/2	Other meat and poultry meat processing	
15.20	Processing and preserving of fish and fish products	Fish Processing
15.20/1	Freezing of fish	
15.20/2	Other fish processing and preserving	
15.31	Processing and preserving of potatoes	Fruit and Vegetable Processing
15.32	Manufacture of fruit and vegetable juice	
15.33	Processing and preserving of fruit and vegetables not elsewhere classified	
15.41	Manufacture of crude oils and fats	Oils and Fats
15.42	Manufacture of refined oils and fats	
15.43	Manufacture of margarine and similar edible fats	
15.51	Operation of dairies and cheese making	Milk Processing
15.51/1	Liquid milk and cream production	
15.51/2	Butter and cheese production	
15.51/3	Manufacture of other milk products	
15.52	Manufacture of ice cream	
15.61	Manufacture of grain mill products	Milling
15.61/1	Grain milling	
15.61/2	Manufacture of breakfast cereals and cereals-based foods	Cereal Processing
15.62	Manufacture of starches and starch products	
15.71	Manufacture of prepared feeds for farm animals	Animal Feed
15.72	Manufacture of prepared pet foods	Petfood
15.81	Manufacture of bread; manufacture of fresh pastry goods and cakes	Bread, Cakes and Biscuits
15.82	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	
15.83	Manufacture of sugar	Sugar

Table 1.3: Breakdown of the main activities by Standard Industry Classification (SIC) code

15.84	Manufacture of cocoa; chocolate and sugar confectionery	Chocolate and Confectionery
15.84/1	Manufacture of cocoa and chocolate confectionery	
15.84/2	Manufacture of sugar confectionery	
15.85	Manufacture of macaroni, noodles, couscous and similar farinaceous products	Pasta Products
15.86	Processing of tea and coffee	Tea and Coffee
15.86/1	Tea processing	
15.86/2	Production of coffee and coffee substitutes	
15.87	Manufacture of condiments and seasonings	Miscellaneous
15.88	Manufacture of homogenised food preparations and dietetic food	
15.89	Manufacture of other food products not elsewhere classified	
15.89/1	Manufacture of soup	
15.89/2	Manufacture of other food products not elsewhere classified	
15.91	Manufacture of distilled potable alcoholic beverages	Beverages and Brewing
15.92	Production of ethyl alcohol from fermented materials	
15.93	Manufacture of wines	
15.93/1	Manufacture of wine of fresh grapes and grape juice	
15.93/2	Manufacture of wine based on concentrated grape must	
15.94	Manufacture of cider and other fruit wines	
15.94/1	Manufacture of cider and perry	
15.94/2	Manufacture of other fermented fruit beverages	
15.95	Manufacture of other non-distilled fermented beverages	
15.96	Manufacture of beer	
15.97	Manufacture of malt	
15.98	Production of mineral waters and soft drinks	

1.8 Economics

The Food and Drink sector is an important part of the manufacturing industry in the UK. It is the largest industrial sector in turnover terms, with a market value in excess of £90 billion. It is a large and diverse sector and accounts for about 9% of manufacturing output and a commensurate fraction of the jobs available in UK manufacturing. **Table 1.3** on page 11 shows a breakdown of the main activities by SIC code and it is clear that a wide range of activities are represented.

In terms of turnover, which one might take as a crude measure of production capacity, activity in the sector is dominated by a relatively small number of large companies. The food and drink industry comprises about ten thousand separate companies, but only about 350 employ more than 400 people. However, these large companies are responsible for about 60% of the turnover within the sector. Given the concentration of the IPPC Directive on installations of large capacity, a relatively small fraction of the total number of companies in this industrial sector might be expected to fall within the scope of the IPPC regulations.

The food processing industry is extremely complex and can be characterised as follows:

- there are a wide range of unit operations
- some of the unit operations such as pasteurisation (see **Section 2.1.6.3** on page 28), and ohmic heating (see **Section 2.2.6** on page 67) are hardly known outside of the immediate industry
- it is estimated that 65% of the industry is batch process
- the consumer market is becoming more sophisticated and demanding
- there is a continual need for process innovation
- plant and equipment needs to be flexible to respond to changes in demand
- quality of production is paramount (and is matched only by pharmaceutical standards)

These factors contribute to making the plant and equipment of food production increasingly complex. Associated abatement equipment needs to be equally flexible and adaptable. There is a potential reluctance to invest in large capital abatement plant when it may be made redundant by a change in the production process, however, changes in the process are opportunities for environmental investment.

The food and drink market-place is characterised by:

- Short time-to-market and competitiveness, where the time between product conception and delivering the product to the market-place is continually reducing; against a background of increasing competitiveness and reduced margins, the emphasis during product development is on the production process itself.
- Product innovation with more and more product variations available now to the consumer; this implies that existing products face stiffer competition and product lifetimes become shorter, with the result that manufacturing processes and production lines require change more frequently.
- Product complexity with the introduction of new flavours, mixtures and combinations of products, pre-prepared products, new packaging, etc..
- The production runs also become shorter as tastes change more frequently.
- Raw materials are generally natural and are therefore more variable than other sectors.

All of these factors contribute to the dynamic and complex nature of food production. While this can imply the potential for more frequent upgrade of processing equipment, it has the drawback of providing a degree of instability.

2 Techniques for pollution control

BAT Boxes to help in preparing applications

To assist Operators and the Regulator's officers in respectively making and determining applications for PPC Permits, this section summarises the indicative BAT requirements (i.e. what is considered to represent BAT for a reasonably efficiently operating installation in the sector). The indicative BAT requirements may not always be absolutely relevant or applicable to an individual installation, when taking into account site-specific factors, but will always provide a benchmark against which individual Applications can be assessed.

Summarised indicative BAT requirements are shown in the "BAT boxes", the heading of each BAT box indicating which BAT issues are being addressed. In addition, the sections immediately prior to the BAT boxes cover the background and detail on which those summary requirements have been based. Together these reflect the requirements for information laid out in the Regulations, **so issues raised in the BAT box or in the introductory section ahead of the BAT box both need to be addressed in any assessment of BAT.**

Although referred to as indicative BAT requirements, they also cover the other requirements of the PPC Regulations and those of other Regulations such as the Waste Management Licensing Regulations (see Appendix 2 for equivalent legislation in Scotland and Northern Ireland) and the Groundwater Regulations, insofar as they are relevant to PPC permitting.

For further information on the status of indicative BAT requirements, see **Section 1.1** on page 1 of this guidance or **Guidance for applicants**.

It is intended that all of the requirements identified in the BAT sections, both the explicit ones in the BAT boxes and the less explicit ones in the descriptive sections, should be considered and addressed by the Operator in the Application. Where particular indicative standards are not relevant to the installation in question, a brief explanation should be given and alternative proposals provided. Where the required information is not available, the reason should be discussed with the Regulator before the Application is finalised. Where information is missing from the Application, the Regulator may, by formal notice, require its provision before the Application is determined.

When making an Application, the Operator should address the indicative BAT requirements in this Guidance Note, but also use the Note to provide evidence that the following basic principles of PPC have been addressed:

- The possibility of preventing the release of harmful substances by changing materials or processes (see **Section 2.1** on page 15), preventing releases of water altogether (see **Section 2.2.2** on page 48), and preventing waste emissions by reuse or recovery, have all been considered, and
- Where prevention is not practicable, that emissions that may cause harm have been reduced and no significant pollution will result.

This approach should assist Applicants to meet the requirements of the Regulations to describe in the Applications techniques and measures to prevent and reduce waste arisings and emissions of substances and heat - including during periods of start-up or shut-down, momentary stoppage, leakage or malfunction.

2.1 In process controls

(includes “directly associated activities” in accordance with the PPC Regulations)

Indicative BAT requirements:
1 See each subsection of this section 2.1.

2.1.1 Process control

Product loss or wastage is a significant benchmark for the food and drink industry and are useful guidelines for an Operator to assess the performance of the installation against industry standards. Some examples are given below (refer to **Section 1.1** on page 1 for an explanation of standards for new and existing installations).

Improved process control inputs, conditions, handling, storage and effluent generation will minimise waste by reducing off-specification product, spoilage, loss to drain (for example, fitting a level switch, float valve, or flow meter will eliminate waste from overflows), overfilling of vessels, water use and other losses.

Table 2.1: Product loss or wastage

Subsectors	Percentage of raw material loss	Water:final product ratio
Liquid Milk	0.7–1% wastage	0.6:1
Soft Drinks	1% wastage	1:1
Brewing	4–6% wastage (post-fermentation)	4:1

Selection of process techniques also has a bearing on product loss. While selection is primarily based on product requirements, it will also have implications for pollution. Operators should consider this trade-off when implementing BAT. For an example see **Section 2.1.3.4** on page 20, Peeling.

It is important that process monitoring and control equipment selected is designed, installed, calibrated and operated so that it will not interfere with hygiene conditions in the production process and itself lead to product loss and waste. Measures, which should be implemented as appropriate, include those in **Table 2.2** below.

Table 2.2: Process monitoring and control equipment

Technique	Application	Outcome
Temperature measurement	Storage and processing vessels, transfer lines, etc.	Reduced deterioration of materials and out-of-specification products
Pressure Measurement	Indirect control of other parameters, for example flow or level	Minimise waste from material damaged by shear friction forces
Level measurement	Storage and reaction vessels	Prevent storage overflow of materials and associated wastage from storage or reaction tanks; minimise waste from transfer losses in inaccurate batch recipes in vessels; and minimise out-of-date stock or production losses due to insufficient material

Table 2.2: Process monitoring and control equipment

Flow measurement	Transfer lines	Accurate addition of materials to processing vessels and minimise excessive use of materials and formation of out-of-specification products
	Steam supply	Maintain correct operating temperature and minimise waste from underheated or overheated materials and products
	Cleaning systems	Control and optimise water use, and minimise effluent generation
Flow control	Constant flow valves	Control flow rate to water ring vacuum pumps
	• Flow regulators	Control process water flow rates for specific processes

Packing line efficiency

Poorly designed and operated packing lines cause many companies to lose as much as 4% of their product and packaging. To improve efficiency and productivity and to reduce wastage, individual machines should be correctly specified so that they work together as part of an efficient overall design.

2.1.2 Materials handling, unpacking, storage

Summary of the activities

Materials handling applies to the receipt, storage and internal conveying of raw materials, intermediate products and final products.

Solid materials are commonly delivered in bags on pallets. They are transported with forklift trucks, and stored in a store. The same holds for liquid ingredients in containers. Larger amounts of solid raw materials and powders are mostly delivered in bulk trucks. These are off-loaded directly for processing or stored in silos. Solid raw materials can be conveyed by water (vegetables, roots, tubers), by air (solid particles, powder) or by conveyer belts and elevators.

Conveyor systems include:
- gravity systems (direct flow to receptacle)
- mechanical systems (belts, screw conveyors or buckets)
- pneumatic systems (positive or negative pressure systems)
- fans

Liquid raw materials are normally delivered in bulk tankers and then pumped into storage tanks. Internal transport of liquid is carried out by pumping through, sometimes extensive and complex, piping systems.

Environmental impact

Water: Leakages, for example from pipework or flume systems. Effluent from cleaning. Results in the release of suspended solids (both organic and/or inorganic) and soluble compounds (both organic and/or inorganic) to water, which leads to a considerable biochemical oxygen demand and turbidity.

Air: Potential emissions from vessel vents whilst filling, which could consist of particulates, gases and odours. Dust and particulate from conveyor systems.

Land: Deposition from emissions to air and contamination from leaking pipework.

Waste: Residues from vessels and other material handling equipment. Reworked for sale as animal feed where possible.

Energy: Materials handling is almost exclusively electrically driven.

Accidents: Spillage from, for example, flume systems or cleaning activities or transfer of materials, for example containers being dropped. Overfilling of storage vessels.

Noise: No issue from vessels and static conveying equipment, but there might be noise from certain types of vehicle-mounted blowers used to discharge solids and liquids from road vehicles into silos and other vessels. Safety horns on forklift trucks may also be a factor.

Indicative BAT requirements for storage and handling of materials:

1 The main control issues are:
- cleaning techniques – see **Section 2.1.11** on page 40
- air emissions from conveyors – see **Section 2.5** on page 83
- accidents, for example overfilling of storage silos – see **Section 2.8** on page 90

2 No further issues are identified.

2.1.3 Raw materials preparation

2.1.3.1 Feedstock cleaning (washing and soaking)

Summary of the activities

The objective of washing is to remove and separate contaminating materials (dirt) from the food in order that (the surface of) the food is in a suitable condition for further processing. Contaminants can be soil, micro-organisms, pesticide residues, etc. Washing is widely applied as a first processing step to root crops, potatoes, fruits and vegetables. Soaking is predominantly applied in processing of legume seeds.

Large volumes of water are required, especially for root vegetables, which carry a lot of earth, and leafy vegetables, which have a large surface area. Mechanical or air flotation techniques (also see **Section 2.2.2** on page 48) may be employed to aid soil removal and reduce the quantity of water used. Some degree of recirculation or re-use of water from other operations is common. Wastewater from pre-washing mainly contains field debris and soil particles with small fragments of the fruit or vegetable. If detergents are used to increase cleaning efficiency, they will contribute to the COD of the wastewater.

There are many types of washing machines and systems adapted to the material to be cleaned. Washing is carried out by vigorous spraying with water (sometimes chlorinated) and immersion, with the aid of brushes or by shaking and stirring. Sometimes surface active agents are added. Sometimes warm water is used. However, the use of warm cleaning water may accelerate chemical and microbiological spoilage, unless careful control on the washing time and process is carried out. The dirt, once loosened, usually differs so greatly from the product that the actual separation of dirt and product is quite simple (for example, by sedimentation).

Soaking is performed by putting the legume seeds in water, where the soaking time varies with variety and species, and with length and conditions of storage. Traditionally, dry beans are soaked overnight (8–16 h) in cold water. High temperature soaking accelerates hydration.

Environmental impact

Air: Odour from hot water washes.

Water: For washing and soaking often large volumes of water are required and large volumes of waste water with high concentrations of dissolved and suspended solids are produced.

Land: No direct impacts.

Waste: The dirt that is removed during washing is often of a solid nature (soil, plant remnants, etc.). From washing of sugar beets and potatoes, considerable amounts of soil result, which is going back to arable land or landfills.

Energy: Heat required for warm washing.

Accidents: Spillage of wash waters. Overloading of effluent systems.

Noise: Not applicable.

Indicative BAT requirements for wet feedstock cleaning:

1. The Operator should demonstrate that water-efficient techniques are being used. For example, water consumption can be reduced by working in counter-current or by recycling the water after cleaning (sedimentation, settlement, filtration, etc.) (see **Section 2.4.3** on page 78).
2. The other main control issues are:
   - effluent treatment – see "Processes using heat" on page 46
   - odour – see **Section 2.2.6** on page 67
   - accidents – see **Section 2.8** on page 90
3. No further issues are identified.

2.1.3.2 Dry cleaning

Summary of the activities

Dry cleaning procedures are used for products with low moisture content and mechanical strength, for example grains and nuts. The main groups of equipment used for dry cleaning are:

- air classifiers
- magnetic separators
- sieving and screening

Environmental impact

Air: Dust from air classifiers and screens.

Water: Cleaning of screens.

Land: Deposition of emissions to air.

Waste: Rejected material.

Energy: Required for air flow.

Accidents: Not applicable.

Noise: Significant.

Indicative BAT requirements for dry cleaning:

1. The main control issues are:
   - emissions to air – see **Section 2.2.1** on page 44
   - noise – see **Section 2.9** on page 94
2. No further issues are identified.

2.1.3.3 Sorting, screening, grading and trimming

Summary of the activities

Most raw materials contain contaminants, and/or have components that are inedible, or have variable physical characteristics. Processing techniques like sorting, grading, screening, de-hulling and trimming are necessary to reach uniformity of the raw material for further processing. Those processing techniques are widely used as a first step in processing of fruits and vegetables (legumes), but also for meat, eggs and fish.

Sorting and/or screening is the separation of raw materials into categories on the basis of shape, size, weight, image and colour.

In size sorting, solids are separated into two or more fractions on the basis of different sizes, usually by sieving and screening. Size sorting is important for food pieces that have to be heated or cooled. Large differences in size would cause over- or under-processing. For size sorting, various types of screens and sieves, with fixed or variable apertures, can be used. The screens may be stationary, rotating or vibrating.

Shape sorting is accomplished manually or mechanically (for example, with a belt-and-roller sorter).

Weight sorting is a very accurate method and is therefore used for more valuable foods (cut meats, eggs, tropical fruits, certain vegetables).

Image processing is used to sort foods on the basis of length, diameter, number of surface defects and orientation of food on a conveyor. The images of the surface are recorded by a video camera and processed by a microprocessor. The information is compared with pre-programmed specifications of the product. The product is either rejected (blasted away with compressed air) or can be moved into a group with similar characteristics. Image sorting is used, for example, on a large scale in the production of french fried potatoes to reject fries with defects and deviating shape.

Colour sorting can be applied at high rates using microprocessor-controlled colour sorters. With photo-detectors the reflected colour of each piece is compared with pre-set standards. Defective pieces are rejected by blasting with compressed air. Typical applications are sorting of peanuts, beans, rice, diced carrot, maize kernels and small fruits.

Grading means the assessment of a number of characteristics of a food to obtain an indication of overall quality of a food. Grading is mostly carried out by trained operators. Meats, for example, are examined by inspectors for disease, fat distribution, carcass size and shape. Other graded foods include cheese and tea. In some cases for grading of foods the results of laboratory analyses are used. Grading is more expensive than sorting (looking at only one characteristic) due to the high costs of skilled personnel. However, many characteristics cannot be examined automatically. Trained operators are able to assess many characteristics simultaneously, producing a uniform high-quality product.

Trimming is meant for removal of inedible parts and parts with defects or cutting to a size feasible for further processing. Trimming is carried out manually or by rotating knives.

Environmental impact

Air: Odour and dust from screening.

Water: Cleaning of equipment.

Land: Indirect effects from wastes seen as suitable for landspreading.

Waste: The material that is sorted out or removed is recovered as far as possible and often used as feed for cattle or pigs. Otherwise sent for disposal.

Energy: Mainly electrical.

Accidents: Not applicable.

Noise: Some machinery noise within the immediate process area.

Indicative BAT requirements for sorting, screening, grading and trimming:

1 The main control issues are:
- cleaning techniques – see **Section 2.1.11** on page 40
- air emissions from screening – see **Section 2.2.1** on page 44

2 No further issues are identified.

2.1.3.4 Peeling

Summary of the activities

Many vegetables and some fruits require peeling, which can be a major source of BOD and TSS, and represents a substantial proportion of the total wastewater volume. Peeling can be achieved by mechanical cutting or abrasion; or by the application of steam, hot water or heated air. Caustic soda is often used to soften the cortex so that the peel can be more easily removed by mechanical scrubbers or high-pressure water sprays (which also removes any residual caustic).

Conventional steam or hot water peeling uses large quantities of water (up to four times that required for caustic peeling) and produces wastewater with high levels of product residue. At potato processing installations, the peels can contribute up to 80% of the total BOD. In fruit processing, peeling wastewater can account for as much as 10% of the total wastewater flow and 60% of the BOD. Dry caustic peeling methods can greatly reduce the volume and strength of the wastewater from this operation and allow for the collection of peel as a pumpable slurry.

The use of caustic in peeling may lead to pH fluctuations in the wastewater. Some produce (e.g. tomatoes) requires strong caustic solutions and the addition of wetting agents. Dry caustic peeling tends to have a lower caustic consumption than wet methods.

Flash steam peeling is a batchwise process. The raw materials (roots, tubers) are treated in a pressure vessel and exposed to high-pressure steam (1500 to 2000 kPa). The high temperature causes a rapid heating and cooking of the surface layer (within 15 to 30 s). The pressure is then instantly released, which causes flashing off of the cooked skin. Most of the peeled material is discharged with the steam (this results in the collection of a concentrated waste stream). Remaining traces are sprayed off with water. The process has a lower water consumption than other “wet” peeling methods.

In knife peeling, the materials to be peeled (fruits or vegetables) are pressed against stationary blades (material to be peeled is rotating) or rotating blades to remove the skin. Knife peeling is particularly used for citrus fruits where the skin is easily removed and little damage is caused to the fruits.

In abrasion peeling, the material to be peeled is fed onto carborundum rollers or fed into a rotating bowl, which is lined with carborundum. The abrasive carborundum surface removes the skin, which is then washed away with water. The process is carried out normally at ambient temperature. This has a significantly higher product loss than flash steam peeling (25% loss compared to 8–15% loss) and considerably more liquid effluent.

Caustic peeling involves the material to be peeled being passed through a dilute solution (1–2%) of sodium hydroxide. Owing to this treatment, the skin is softened and can be sprayed off by high-pressure water sprays. Product loss is around 17%. A new development in caustic peeling is so-called dry caustic peeling. The material is dipped in a 10% sodium hydroxide solution. The softened skin is then removed by rubber discs or rollers. This reduces water consumption and produces a concentrated caustic paste for disposal.

Developed for onions, a flame peeler consists of a conveyer belt which transports and rotates the material through a furnace heated to temperatures above 1000°C. The skin (paper shell, root hairs) is burned off. The skin is removed by high-pressure water sprays.

Environmental impact

Air: VOCs, dust and odour from steam and flame peeling.

Water: Treatment of high-pH effluent from caustic. Most peeling operations use water for spraying off the peeled skin, which carries food remnants into the wastewater stream.

Land: No direct impacts.

Waste: Food remnants removed by screens from wastewater.

Energy: Flash steam peeling, caustic peeling and flame peeling require heat. In the other peeling operations, electrical energy is used.

Accidents: Spillage of caustic.

Noise: Not applicable.

Indicative BAT requirements for peeling:

1 The Operator should show that, for a specific feedstock where there is more than one option for peeling techniques, the selection has taken into consideration:
- water and energy efficiency – see **Section 2.4.3** on page 78 and **Section 2.7** on page 86;
- product loss.

2 Other control issues are:
- emissions to air (odour and VOCs)
- cleaning techniques – see **Section 2.1.11** on page 40
- Effluent treatment – see **Section 2.2.2** on page 48
- Waste handling – see **Section 2.5** on page 83, and waste recovery and disposal in **Section 2.6** on page 84

3 No further issues are identified.

2.1.4 Size reduction

2.1.4.1 Grinding and milling

Summary of the activities

Grinding (milling) is a process of size reduction of solid dry material and it is applied where dry solid materials are processed, for example the feed industry, flour milling industry, breweries, sugar industry, dairy industry (milk powder, lactose), etc. A range of grinding (milling) techniques and equipment is available for application to specific types of food for both dry and wet applications. In wet grinding (milling) smaller particle sizes can be attained. Dry grinding (milling) is combined with sieving or air classification, which allows the collection of a wider range of particle size.

A distinction can be made between those processes where the milling is a component of a food process and where it is essentially the process, for example, flour milling and animal feed mills.

Common types of mill used in the food industry are as follows:

- Hammer mills – A horizontal cylindrical chamber is lined with a steel breaker plate. A high-speed rotor inside the chamber is fitted with hammers along its length. The material is disintegrated by impact forces as the hammers drive it against the breaker plate.

- Ball mills – The mill consists of a slowly rotating, horizontal steel cylinder, which is half filled with steel balls (2.5–15 cm in diameter). The attained particle size depends on the speed and size of the balls.
- Roller mills – The mill consists of two or more steel rollers, which revolve towards each other and pull particles of the food material through the space between the rollers (nip). The size of the nip is adjustable for different food materials.
- Disc mills – Consist of one rotatory disc in a stationary casing or of two discs, which rotate in opposite directions. The food material passes through the adjustable gap between disc and casing or between the discs. Pin-and-disc mills have intermeshing pins fixed on the discs and casing. This improves the effectiveness of milling.

A developing technique for the size reduction of dry foods is the “nibblers” which use a grating action, as opposed to grinding. It is claimed that there are reductions in noise, dust and temperature.

Environmental Impact

Air: Particulates (dust) – grain and feed mills typically have emissions from three sources:

- grain receiving
- process emission sources, e.g., cleaning, breaking, milling and sieving
- product removal, i.e. transfer from storage to transport

Water: Deposition from air emissions.

Land: Deposition from air emissions.

Waste: Solid organic waste is generated when equipment is emptied for a next batch or for cleaning. Always some losses occur in such situations. This solid waste can consist of raw materials or waste products. Also particulate caught in cyclones and bag filters.

Energy: Grinding (milling) requires a substantial energy input.

Accidents: Spillage during bulk transfer.

Noise: All grain and animal feed mills. Unit process milling is usually contained within the installation.

Indicative BAT requirements for grinding (milling):	
1	The main control issues are: • product loss – see **Section 2.1.1** on page 15 and **Section 2.4.2** on page 75
2	Other control issues are: • emissions to air (dust and odour) – see **Section 2.2.1** on page 44 • noise – see **Section 2.9** on page 94
3	No further issues are identified.

2.1.4.2 Cutting, slicing, chopping, mincing and pulping

Summary of the activities

The objective of cutting, slicing, chopping, mincing and pulping is to reduce the size of fibrous material. Thereby the aim is to improve the eating quality or suitability of foods for direct consumption or further processing. These activities are very broadly applied in the food industry, for example in processing of meat, fish, cheese, vegetables, fruits, potatoes and various crops (sugar beets). Equipment will be power- or hand-operated, depending on the size of the operations.

For cutting of potatoes for the production of french fries, often so-called hydro cutters are used. The potatoes are conveyed by water at high speed over fixed blades.

In slicing, more or less regular pieces of material are obtained. Slicing equipment consists of rotating or reciprocating blades, which cut the food when it passes beneath. Sometimes the material is pressed against the blades by centrifugal force. In other cases (for slicing meat products) the material is held on a carriage as it travels across the blade. Harder fruits (like apples) are simultaneously sliced and decored as they are forced over stationary knives inside a tube.

A variant of slicing is dicing (applied to vegetables, fruits and meats). The food is first sliced and then cut into strips by rotating blades. The strips are fed to a second set of rotating knives, which operate at right angles to the first set and cut the strips into cubes.

Many products require the breaking down of raw materials into small particles (comminution). Chopping can perform this. Chopping into a coarse pulp is applied to meat, fruits and vegetables. In chopping, the material is placed in a slowly rotating bowl and subjected to a set of blades rotating at high speed.

This technique, normally called bowl chopping, is widely used in the production of sausages and similar products. In bowl chopping, the degree of comminution can be varied depending on knife speed and cutting time, and can reduce the material to an emulsion if so required.

Mincing is mainly used for size reduction and homogenisation of meat.

Pulping is applied on fruit and vegetables with the aim of size reduction and making a homogeneous mass. For this purpose a moving rough surface ruptures the fruits (vegetables) and squeezes the material through a gap. Most commonly used are drum pulpers and disc pulpers. Sometimes another aim in the pulping process is also juice extraction.

A developing cutting technique is the use of ultrasonic cutting.

Environmental impact

Air: Not applicable.

Water: Water from hydro cutters and cleaning of equipment and may contain product remnants like small particles from meat, fruit and vegetables.

Land: No direct impacts.

Waste: Residues from dry cleaning and drain catchpots and screens.

Energy: Equipment is usually electrically powered.

Accidents: Not applicable.

Noise: Some high-speed, power-operated equipment will generate high noise levels, e.g. circular saws used to cut through bones and bowl cutters.

Indicative BAT requirements for cutting, slicing, chopping, mincing and pulping:	
1	The main control issue is: • cleaning techniques – see **Section 2.1.11** on page 40
2	No further issues are identified.

2.1.4.3 Mixing, blending and homogenisation

Summary of the activities

The aim of this group of operations is to obtain a uniform mixture from two or more components or to obtain an even particle size distribution in a food material. This may result in improved characteristics and eating quality. These are widely applied in almost all sectors in the food industry.

Mixing (blending) is the combination of different materials and their spatial distribution until a certain degree of homogeneity is achieved. In the food industry various mixing operations can be distinguished.

Solid/solid mixing is encountered for mixed feed, blends of tea and coffee, dried soup, cake mixes, custard, ice cream mixes, etc.

Solid/liquid mixing is applied for canned goods, dough, dairy products, etc. Solid/liquid mixing is also applied for the production of chocolates and sweets; the ingredients are mixed in a more or less liquid state and solidify on cooling.

Liquid/liquid mixing is applied for making emulsions like mayonnaise, margarine and mixtures of solutions.

Liquid/gas mixing is used in making ice cream, whipping cream, some sweets and baked goods. For spray drying, also a mixture of liquid in a gas is made.

Commonly applied mixers for solid/solid mixing are rotating drums, other rotary mixers and mixing screws in cylindrical or cone-shaped vessels. For viscous solid/liquid mixing, kneading machines are used. For low viscous solid/liquid mixtures and liquid/liquid mixtures, various types of stirrers, impellers and agitators are applied. For liquid/gas mixing, atomisers are used for bringing small liquid droplets in a gas. In making ice cream, whipped cream or a foam, small gas bubbles are brought into a liquid; various methods exist for this.

The aim of homogenisation is to attain a more even particle size or a more homogeneous blend of materials. It is, for example, applied on whole milk to reduce the size of fat globules and to prevent creaming of fat. The liquid (whole milk) is pressed under high pressure (200–300 bar) through a small orifice.

Environmental impact

Air: Odour in those operations in which volatile compounds are involved. Particulates (dust) are emitted in operations in which solids are involved, like solid/solid mixing.

Water: Cleaning.

Land: No direct impacts.

Waste: Product removed by cleaning.

Energy: Some of the operations of this group require a substantial energy input.

Accidents: Fire/explosion risk from solid/solid mixing.

Noise: Not applicable.

Indicative BAT requirements for mixing, blending and homogenisation:	
1	The main control issues are: • cleaning techniques – see Section 2.1.11 on page 40 • emissions to air (dust and odour) – see Section 2.2.1 on page 44
2	No further issues are identified.

2.1.5 Forming, moulding and extruding

Summary of the activities

Forming, moulding and extruding are operations meant for attaining a certain shape of solid materials.

Forming/moulding is an operation widely applied for the production of bread, biscuits, confectionery and pies. In cheese-making, moulding is also an important process step.

In forming/moulding the material is brought in a more or less viscous form in the moulds, with subsequent material becoming firmer and solid up to the point that it has a fixed shape.

Extruders are classified according to the method of operation:

- cold extruders where the temperature of the feedstock remains at ambient;
- extrusion cooking or hot extrusion where the feedstock is heated >100°C.

Extrusion is widely used for the production of meat sausages, pasta products such as macaroni, vermicelli and spaghetti, but also for a lot of other products like confectionery and starch-based snack food. It plays a significant part in animal feed manufacture.

Extrusion can be seen as a continuous process of shaping. The material is kneaded under high pressure and pressed continuously through openings of the required shape. In so-called cooking extruders the material is also heat-treated (cooked), for example to solubilise starches. Extruders can contain one or two screws. The rotation of the screws is responsible for the transport of the material, mechanical treatment and pressure build-up.

Environmental Impact

Air: Odour from extrusion cooking arising from extruder vents as moisture is flashed off as steam.

Water: Waste is generated during cleaning of equipment.

Land: No direct impacts.

Waste: Some solid waste may be generated due to loss of product at the start and stop of the production process.

Energy: Extruders typically show relatively high power consumption.

Accidents: Not applicable.

Noise: Not applicable.

Indicative BAT requirements for forming, moulding and extrusion:	
1	The main control issues are: • cleaning techniques – see **Section 2.1.11** on page 40 • emissions to air (dust and odour) – see **Section 2.2.1** on page 44
2	No further issues are identified.

2.1.6 Heat processing using steam or water

2.1.6.1 Blanching

Summary of the activities

Blanching is an important step in processing of green vegetables and fruits and is their exposure to high temperatures for a short period of time. The primary function of this operation is to inactivate or retard bacterial and enzyme action, which causes rapid degeneration of quality. Other desirable effects of blanching include the expelling of air and gases in the product, as well as the reduction in the volume of the product.

Depending on the product and/or availability of equipment, blanching may be accomplished by:

- immersion in hot water (80 to 100°C)
- exposure to live steam

The operation is normally carried out in horizontal chambers. The residence time in the blancher can vary from approximately 1 to 5 minutes depending on the vegetable or fruit being blanched.

Environmental Impact

Air: Emission of steam/water vapour to atmosphere and, depending on the raw material being blanched, the exhaust air may contain VOCs, which may give rise to odour.

Water: Production of a low-volume, high-strength effluent. Typical characteristics of the wastewater arising from the blanching operation are shown in **Table 2.3** below.

Table 2.3: Typical characteristics arising from blanching

Volume of wastewater	2–120 m^3/tonne of product
BOD	10–250 kg/tonne of product
Suspended solids	2.5–150 kg/tonne of product

Land: No direct impacts.

Waste: Removal of solid residues from the bottom of the blanchers.

Energy: Heat is used for heating up the blanching water. Steam is used in flash blanching. Heat should be recovered from the condensed steam discharged to atmosphere.

Accidents: Uncontrolled release of blanching waters may overload the effluent management system.

Noise: Not applicable.

Indicative BAT requirements for blanching:

1 The main control issues are:
- water use (blanching water may be re-used in other parts of the process);
- cleaning techniques – see **Section 2.1.11** on page 40
- emissions to air (dust and odour) – see **Section 2.2.1** on page 44
- effluent treatment – see **Section 2.2.2** on page 48
- energy efficiency – **Section 2.7** on page 86

2 No further issues are identified.

2.1.6.2 Evaporation

Summary of the activities

Evaporation is the partial removal of water from liquid food by boiling. For instance, liquid products can be concentrated from 5% dry solids to 45% or even higher depending on the viscosity of concentrates. Evaporation is used to preconcentrate food, increase the solid content of food and to change the colour of food, and is used to process milk, starch, coffee, fruit juices, vegetable pastes and concentrates, seasonings, sauces, and in sugar processing.

Steam or vapour is usually used as heating medium. The latent heat of condensation is transferred to the liquid food to raise its temperature to the boiling point and evaporate the water. The vapour is then removed from the surface of the boiling liquid.

Since food products are heat-sensitive, it is often necessary to work at low temperatures. This is achieved by boiling the liquid part under vacuum. Evaporation occurs normally in a range of 50 to 100°C. At its simplest, evaporation is carried out by immersed electric heaters boiling off water to atmosphere.

The most commonly used equipment are multi-stage shell and tube evaporators, sometimes plate evaporators. Shell and tube evaporators may be of natural or forced circulation, climbing or falling film types.

Centri-therm evaporators, wiped film evaporators (WFE) and thin film evaporators are specially designed for the evaporation of highly viscous products.

For large-scale evaporation requiring significant energy, for example in sugar beet processing, starch processing, evaporation of milk and whey, multiple-effect evaporators are used. These use fresh steam to boil off water vapour from the liquid in the first effect. The evaporated water still has sufficient energy to be the heat source for the next effect, and so on. Vacuum is applied in a multiple-effect chain in order for the water to boil off. The liquid being worked on is passed from one evaporator body through the others so that it is subject to multiple stages of evaporation. In this way one unit of steam injected in the first evaporator might remove three to six units of water from the liquid.

Other options to reduce energy consumption by re-using heat contained in vapours include:

- vapour recompression
- pre-heating using the vapour to heat incoming feedstock or condensed vapour to raise steam in a boiler

Periodical chemical cleanings are carried out in order to ensure efficient heat transfer. The cleaning frequency is, depending on product and evaporator type, from 8 to more than 48 hours.

Environmental Impact

Air: Odour and particulate arising from incondensable gases vented to ensure efficient heat transfer and entrainment, where a fine mist of concentrate is produced during violent boiling.

Water: During processing product compounds gradually deposit on the heat exchange surfaces and this fouling will require cleaning to prevent reduction in heat transfer. Cleaning is carried out using alkaline and acid solutions, the order depending on the composition of the deposits.

Land: No direct impacts.

Waste: Product removed by cleaning.

Energy: Steam raising requirements.

Accidents: Not applicable.

Noise: Noise is often produced from evaporation and will be principally generated by the thermo compressor, the mechanical compressor, the steam ejectors and the high velocity of the fluids in the piping.

Indicative BAT requirements for evaporation:

1. The main control issues are:
   - cleaning techniques – see **Section 2.1.11** on page 40
   - emissions to air (dust and odour) – see **Section 2.2.1** on page 44
   - effluent treatment – see **Section 2.2.2** on page 48
   - energy efficiency – see **Section 2.7** on page 86
2. No further issues are identified.

2.1.6.3 Pasturisation, sterilisation, UHT

Summary of the activities

Heat treatment of products is one of the main techniques in the food industry for conservation. Heat treatment stops bacterial and enzyme activity; this prevents loss of quality and keeps food non-perishable. In heat treatment various time/temperature combinations can be applied, depending on product properties and shelf-life requirements.

In pasteurisation, generally a heating temperature below 100°C is applied, which means a part reduction of enzyme and bacterial activity and a limited shelf-life. Sterilisation commonly means a heat treatment over 100°C for such times that a stable shelf-life is achieved. UHT (ultra heat treatment) means a heat treatment over 100°C during very short times; it is especially applicable to low-viscosity liquid products.

Batchwise pasteurisation is carried out in (agitated) vessels. Sometimes the product (i.e. beer, fruit juices) is pasteurised after bottling or canning. Then the containers with product are immersed in hot water or led through a steam tunnel.

For continuous pasteurisation, flow-through heat exchangers (tubular, plate and frame) are applied, with heating, holding and cooling sections.

Generally, for sterilisation, the product is canned or bottled and then heat-treated in a retort in hot water (under overpressure) or steam. Sterilising retorts may be batch or continuous in operation.

For UHT treatment, indirect heating in plate and frame or tubular heat exchangers is applied. However, direct steam injection or steam infusion also can be applied.

Environmental impact

Air: Potential for fugitive losses from refrigeration systems.

Water: “Once-through cooling” post-heat treatment requires substantial quantities of cooling water. Fouling of heat transfer surfaces requires cleaning.

Land: No direct impacts.

Waste: Product residues and concentrated flushes can be collected for recovery or animal feed.

Energy: Energy required in the form of steam or hot water treatment and for cooling. Cooling can be accomplished by once-through cooling or with a recirculating chilled water system. The latter will involve a mechanical refrigeration system.

Accidents: Not applicable.

Noise: Not applicable.

Indicative BAT requirements for pasteurisation, sterilisation and UHT:	
1	The main control issues are: • water use – see **Section 2.4.3** on page 78 • the Operator should justify why the re-use of “once-through cooling” waters is not possible • cleaning techniques – see **Section 2.1.11** on page 40 • fugitive emissions to air (refrigerants) – see **Section 2.2.4** on page 64 • energy efficiency – see **Section 2.7** on page 86
2	No further issues are identified.

2.1.7 Heat processing using hot air

2.1.7.1 Baking

Summary of the activities

The main aim of baking is to enhance the eating quality (taste, texture) of food by heating with hot air. A secondary objective of baking is preservation by destruction of micro-organisms and reduction of water activity at the surface of the food. However, the shelf-life of most baked foods is limited, unless products are refrigerated or packaged.

Baking is applied on a large scale to flour-based products like bread and bakery products and also to fruits and vegetables. Baked vegetables may, for example, be used as a filling or topping component in food products such as pies, pizzas and snack foods.

In a baking oven the food is exposed to hot air (110 –240°C) or infrared irradiation. The moisture at the surface is evaporated and removed by the circulating air. When the rate of moisture loss at the surface exceeds the rate of transport of moisture from the interior of the product to the surface, the surface dries out and a crust is formed.

The ovens used for baking of bread and bakery products can be classified into direct or indirect heating types, using hot air as the heat transfer medium. For baking of fruits and vegetables, infrared ovens are applied. All types can be batch or continuous in operation.

Environmental Impact

Air: Products of combustion from natural gas, etc., odour.

Water: Not applicable.

Land: No direct impacts.

Waste: Not applicable.

Energy: For baking, fuel is used in the form of natural gas, propane, butane, oil or electricity. Baking of vegetables is preceded by flash blanching (see **Section 2.1.6.1** on page 25). The energy usage for baking normally ranges from 450 to 600 kJ/kg of product.

Accidents: Not applicable.

Noise: Not applicable.

Indicative BAT requirements for baking:	
1	The main control issues are: • emissions to air – see **Section 2.2.1** on page 44 • low NOx burners • odour – see **Section 2.2.6** on page 67 • energy efficiency – see **Section 2.7** on page 86
2	No further issues are identified.

2.1.7.2 Roasting

Summary of the activities

The aim of the process is to dry and to enhance the aroma and/or to enhance the structure of raw products. Typical products that are roasted are coffee, cereals, nuts, cacao, chicory and fruits.

The raw product is usually exposed to hot air (temperatures over 100°C). Sometimes the raw product is pre-dried. First the water is evaporated from the product. The moisture content is decreased from 8 –20% until less than 1%. If the product reaches a sufficiently high temperature (over 120°C) reactions take place in the product. These so-called Maillard reactions are important in the formation of aromas in coffee and cacao. The duration of this roasting process is dependent on the product and the specific aromas that are required. Roasting times for coffee range between 1 and 20 minutes, whereas for cacao and other products it can be up to 120 minutes. When the product temperature reaches its required level, the Maillard reactions are stopped by either cooling the product with air or by quenching the product with water followed by cooling with air.

The roasting can be done either batchwise or continuously. Typical equipment for batch roasting can be a drum roaster, a column roaster (cacao), a rotating disc roaster, a fluidised bed roaster, a spouting bed roaster, etc. All equipment has in common that the product is heated and agitated at the same time. The product can be in direct contact with the hot air (convective heat transfer) or in contact with a heated surface (conductive heat transfer). Usually it is a combination of both. The cooling takes place in separate equipment. This can be a cooling sieve where air is pulled through or a spouting bed cooler or any other equipment where the raw product is in contact with fresh air. Quenching with water can take place in the roasting chamber and sometimes in the cooling equipment.

Environmental Impact

Air: VOCs will be present at both the outlet of the roaster and the cooler, with higher levels at the roaster outlet. VOC levels are higher when the product is roasted to a higher degree (e.g. the product temperature at the end of the roasting process is higher). The difference of emissions between a low roasted and a very high (= very dark) roasted product can be a factor of 10. Usually the overall average emission of VOCs is between 150 and 1500 mg carbon/kg green coffee. For batch roasters the highest concentrations are emitted just before the end of the roasting process.

During the roasting process the skins (chaff) will be separated and discharged with small particle size product components.

Water: Small amounts of water are used for quenching but is either partly evaporated or absorbed by the product.

Land: Potential deposition from air emissions of dust.

Waste: Dust collected in the air abatement system, for example within the cyclones. For coffee this can be between 0.1 and 1.5% of the amount of green coffee.

Energy: The typical energy consumption can range from 900 to 3000 kJ/kg. This depends on the type of roaster that is being used and also on the layout of the roast off-gas system.

Accidents: Not applicable.

Noise: Not applicable.

Indicative BAT requirements for roasting:

1 The main control issues are:
- emissions to air – see **Section 2.2.1** on page 44
- odour – see **Section 2.2.6** on page 67
- energy efficiency - see **Section 2.7** on page 86

2 No further issues are identified.

2.1.7.3 Drying (liquid solid) and dehydration (solid/solid)

Summary of the activities

Drying is defined as the application of heat under controlled conditions to remove the water present in liquid foods by evaporation, yielding solid products. It differs from evaporation, which is employed on liquids, yielding concentrated liquid products. The main purpose of drying is to extend the shelf-life of foods by a reduction in water activity. Typical applications of drying technologies include milk, coffee, tea, flavours, powdered drinks and sugar, among others.

Two different principles can be applied for drying.

Table 2.4: Drying principles

Hot air drying	Surface drying by heat conduction through a heat transfer system
Hot air is used as heating medium and is in direct contact with the liquid product. The heat transferred from the hot air to the product causes water evaporation. The main types of hot air dryers are: • bin dryers • tray dryers • tunnel dryers • conveyor (belt dryers) • fluidised bed dryers • kiln dryers • pneumatic dryers • rotary dryers • spray dryers	The heating medium is not in contact with the wet food but separated from it by a heat transfer surface. The heat is transferred by conduction through the surface and by convection from the hot surface to the food product for evaporating and removing water from the food. This has two main advantages compared to hot air dryers: • less air volume and therefore higher thermal efficiency • the process may be carried out in the absence of oxygen The two main types of surface dryers are: • drum (roller dryers) • vacuum band/vacuum shelf dryers

Fluidised bed dryers present several advantages:

- good control over drying conditions
- relatively high thermal efficiencies and high drying rates
- very high rates of heat and mass transfer and consequently short drying times
- drying can take place with air temperatures below 100°C

Ultrasonic drying is a developing alternative technique for certain foods.

Environmental Impact

Air: Spray dryers, for example, have air inlet temperatures up to about 215°C decreasing to an outlet temperature of about 95°C. In spray dryers the requirement for high feed moisture content to enable the food to be pumped to the atomiser, results in a higher loss of volatiles and the outlet air is loaded with dried powder. This gives rise to emissions of VOCs, particulate and odour bag filters.

Water: Wastewaters from cleaning and wet scrubber systems.

Land: Deposition of particulate if air emission abatement is inadequate.

Waste: Residues arising from cleaning of equipment or dust trapped in cyclones or bag filters. Both arisings can be either recycled or reworked for animal feed.

Energy: For evaporation of water theoretically 2.2 MJ/kg is required. Owing to energy losses in the process in practice the energy consumption for water evaporation (drying) ranges from 2.5 to 3.5 MJ/kg. Spray dryers are large-scale continuous process units with high energy costs. Steam dryers can have a considerably lower energy consumption.

Accidents: Fire/explosion risk especially where there are fine particles in high air/particle ratios, for example, in spray and fluid bed dryers and/or where the product has a significant carbohydrate content. Failure of air emission abatement.

Noise: Not applicable.

Indicative BAT requirements for drying:

1 The main control issues are:
- emissions to air – see Section 2.2.1 on page 44
- Typically exhaust air is passed through cyclones, the outlet air of which may contain dust particles up to 200 mg/m^3 which will require secondary abatement, for example, using fabric filters.
- odour – see Section 2.2.6 on page 67
- energy efficiency – see Section 2.7 on page 86

2 Various measures typically used to reduce heat losses and save energy should be implemented for drying systems. These include:
- recirculation of exhaust air to heat inlet air
- use of direct flame heating by natural gas and low NOx burners
- two-stage drying, for example fluidised beds followed by spray drying followed by fluidised beds
- pre concentrating liquid foods using multiple effect evaporation

3 No further issues are identified.

2.1.8 Heat processing using hot oils

2.1.8.1 Frying

Summary of the activities

Frying is a cooking operation where the food is cooked in edible oil at temperatures in the region of 200°C. Vegetable oil is normally used. Raw material such as fish, potatoes and chicken can be fried, producing products such as fish fingers, potato chips and chicken nuggets.

Product is fed into the fryer on a slatted belt. The fryer is a horizontal chamber, which contains the oil. The product drops into the oil and the expansion of the batter brings the product to the surface of the oil. The slatted belt feeds the product under the main fryer belt, which takes the product through the fryer and controls the frying time. The take-out belt at the end of the fryer lifts the product out of the oil, allows drainage and transfers the product to the inspection and packing belts. The frying temperature and time vary according to the product being processed. Temperatures range from 190 to 205°C and residence times in the fryer are normally around 35 seconds but can go up to as high as 6 minutes.

Environmental Impact

Air: Emissions are dependent on operational temperature (in turn dependent on the product type). High-temperature frying (180 – 200°C) will result in more rapid production of oil breakdown products. The air above a fryer is extracted and vented. This exhaust air will contain VOCs and odour will be associated with the emission.

Water: Wastewater from cleaning will contain fat in the form of both free and emulsified fat.

Land: No direct impacts.

Waste: Spent oil and containers.

Energy: The frying oven normally is heated with steam or hot oil.

Accidents: Not applicable.

Noise: Not applicable.

Indicative BAT requirements for frying:
1 The main control issues are: • emissions to air – see **Section 2.2.1** on page 44 • removal of entrained oil from exhaust gases • exhaust gas recirculation to the burner • odour – see **Section 2.2.6** on page 67 • energy efficiency – see **Section 2.7** on page 86 • recovery of heat in off-gases, for example by recirculation to pre-heat oil or transfer for water heating elsewhere within the installation
2 No further issues are identified.

2.1.9 Processing by the removal of heat

2.1.9.1 Cooling, chilling

Summary of the activities

The objective of cooling and chilling is to reduce the rate of biochemical and microbiological changes, in order to extend the shelf-life of fresh and processed foods. Cooling can be defined as the processing technique that is used to reduce the temperature of the food from processing temperature to storage temperature. Chilling is the processing technique in which the temperature of a food is kept at a temperature between -1°C and 8°C.

Typically the cooling of liquid foods is carried out by passing it through a heat exchanger (cooler). The cooling medium in the cooler can be groundwater, water recirculating over a cooling tower or water (eventually mixed with agents like glycol) which is recirculated via a mechanical refrigeration system (ice-water). Cooling of solid foods and chilling are carried out by contacting the food with cold air or indirectly with a refrigerant like liquid carbon dioxide, liquid nitrogen or a liquid freon.

In cryogenic cooling the food is in direct contact with the refrigerant, which can be solid or liquid carbon dioxide, liquid nitrogen or a liquid freon. The refrigerant evaporates or sublimates, removing the heat from the food and causing rapid cooling.

Environmental impact

Air: Fugitive emissions of refrigerants.

Water: “Once-through cooling" post heat treatment requires substantial quantities of cooling water.

Land: No direct impacts.

Energy: Mechanical refrigeration systems demand substantial amounts of mechanical (electrical) energy.

Other: No issues.

Indicative BAT requirements for cooling and chilling:	
1	The main control issues are: • water use – see **Section 2.4.3** on page 78 • the Operator should justify why the reuse of "once-through cooling" waters is not possible • cleaning techniques – see **Section 2.1.11** on page 40 • fugitive emissions to air (refrigerants) – see **Section 2.2.4** on page 64 • energy efficiency – see **Section 2.7** on page 86
2	No further issues are identified.

2.1.9.2 Freezing

Summary of the activities

Freezing is a method for preservation, where the temperature of a food is reduced below the freezing point of water and a proportion of the water undergoes a change in state to form ice crystals. Several types of food can be frozen, like fruits, vegetables, fish, meat, baked goods and prepared foods (ice cream, pizzas, etc.).

During the freezing process "sensible" heat is first removed to lower the temperature of the food to the freezing point (in fresh foods this includes heat produced by respiration). Latent heat of crystallisation is then removed and ice crystals are formed.

A whole range of methods and equipment for freezing foods is available. The most common are:

- blast freezers
- belt freezers (spiral freezers)
- fluidised bed freezers
- cooled surface freezers
- immersion freezers
- cryogenic freezers

Environmental Impact

Air: Fugitive emissions of refrigerant.

Water: Not applicable.

Land: No direct impacts.

Waste: Not applicable.

Energy: Mechanical refrigeration systems demand substantial amounts of mechanical (electrical) energy.

Accidents: Spillage of refrigerant.

Noise: Compressor noise from larger units.

Indicative BAT requirements for freezing:	
1	The main control issues are: • fugitive emissions to air (refrigerants) – see **Section 2.2.4** on page 64 • energy efficiency – see **Section 2.7** on page 86
2	No further issues are identified.

2.1.9.3 Freeze drying

Summary of the activities

Lyophilisation, commonly referred to as freeze drying, is the process of removing water from a product by sublimation and desorption. The aim of the process is to preserve sensitive material that cannot be dried by evaporation because of the degradation of specific components at high temperature, resulting in loss of taste or other quality aspects. The technique is used for drying coffee extract, spices, soup vegetables, flowers, instant meals, fish, meat, etc.

This process is performed in lyophilisation equipment, which consists of:

- drying chamber with temperature-controlled shelves (this can be a batch chamber, where the trays remain fixed on the heating plates through the drying operation, or a semi-continuous type, in which the trays move through a vacuum lock into a drying tunnel);
- condenser to trap water removed from the product in the drying chamber;
- cooling system to supply refrigerant to the shelves and condenser;
- vacuum system to reduce the pressure in the chamber;
- condenser to facilitate the drying process.

Environmental Impact

Air: Fugitive emissions of refrigerant and odour from dryers.

Water: Wastewater from the condensers, which may contain some product.

Land: No direct impacts.

Waste: Not applicable.

Energy: Mechanical refrigeration systems demand substantial amounts of mechanical (electrical) energy.

Accidents: Spillage of refrigerant.

Noise: Compressor noise from larger units.

Indicative BAT requirements for freeze drying:	
1	The main control issues are: • fugitive emissions to air (refrigerants) – see **Section 2.2.4** on page 64 • energy efficiency – see **Section 2.7** on page 86
2	No further issues are identified.

2.1.10 Separation and concentration of food components

2.1.10.1 Extraction

Summary of the activities

The objective of extraction is to recover valuable soluble components from a raw material by dissolving them in a liquid solvent.

Extraction is applied to a wide variety of food products. Examples include:

- the extraction of sugar from sugar beets or sugar cane

- the extraction of oil from oilseeds
- the extraction of coffee extract from coffee beans
- the extraction of caffeine from coffee beans
- the extraction of various other compounds such as proteins, pectins, vitamins, pigments, essential oils, aroma compounds, flavour compounds, etc., from many different materials

The principle of extraction is that soluble components of a mixture are separated from insoluble or less soluble components by dissolving them in a suitable solvent. Raw materials that are suitable for extraction may contain either solids only, solids and a solution, or solids and a liquid. This is referred to as solid/liquid extraction, sometimes called leaching. When the soluble component is incorporated in a liquid, liquid/liquid extraction may be applied to recover the valuable soluble component.

Commonly the extract is of prime importance. In this case the residue is waste or by-product. It is not always the objective to win one particular compound in pure form from a raw material. Sometimes extraction is intended to separate all soluble compounds from the residue; an example is the extraction of coffee.

The efficiency of the extraction process depends on the selectivity of the solvent. Common solvents are:

- water
- organic solvents like hexane, methylene chloride (dichloromethane), ethyl acetate (ethyl ethanoate) and alcohol (ethanol)
- supercritical carbon dioxide (CO2)

Raw materials are usually pre-treated in order to ensure efficient extraction of desired compounds. For example, sugar beet and sugar cane cut into thin slices, nuts and seeds are ground or flaked, coffee beans are roasted and ground, and tea leaves are dried and ground.

Most common is the method of counter-current extraction. Extraction can be accomplished in either batch or continuous processes. Batchwise counter-current extraction is normally only used for the processing of small amounts of material. In continuously operating extractors the solid material and the liquid (solvent) are transported in continuous counter-current.

In principle, many different methods of transport are possible. Examples of transport systems are:

- perforated trays connected to endless chains and moving horizontally or vertically
- chains in troughs
- screw conveyors transporting the solid material in counter-current flow vertically or sloping – the screws are perforated in order to obtain a uniform flow of liquid
- endless perforated belt – here the solvent is circulated by a pump and sprayed on top of the solid material

One of the difficulties is the separation of the extracted material from the solvent, and recovery of the extracted material from the solvent. The latter can be carried out by evaporation, crystallisation, distillation, steam stripping, etc.

Extraction – super critical fluid (SCF)

The potential for the use of SCF in the food industry has been recognised since the 1970s. There have also been many exaggerated claims about the potential for use in removing cholesterol from eggs, meat, dairy products, etc., and this has perhaps led to a degree of cynicism about the use of SCF.

However, the technology has already been applied on a large scale internationally for extraction purposes for:

- coffee
- tea
- hops

- spices
- flavours

The use of SCF is essentially a combination of the features of distillation (using differences in volatility) and liquid extraction (using differences in component interactions). Increasing pressure and temperature of a substance takes it closer to its critical point. Beyond this point the fluid exhibits enhanced solvent qualities which are pressure-dependent and can thus be varied to suit the application.

The particular advantage of CO_2 in food processing applications is that the critical point is reached at near ambient conditions (31.1°C). This makes it amenable to processing of heat-sensitive flavours such as coffee and tea.

The use of supercritical carbon dioxide in the caffeine extraction process has eliminated the use of the more conventional hexane solvent. It is clear that SCF is a high-energy process but there are advantages in terms of VOC use and air emissions.

The potential for SCF extraction in the food industry is enormous. In addition to the established applications (coffee, tea, hops and spices) there has already been a lot of work done in the fields of

- edible oil extraction (replacing hexane)
- corn and wheat germ
- sunflower seeds
- peanuts
- concentrations of fish oils
- extraction of fat from potato crisps

Environmental Impact

Air: VOCs arising from extraction with organic volatile solvents. Extraction may also cause odour, due to emission of H_2S and organic compounds. When extraction with water takes place, water vapour containing non-condensable VOCs may be released to the atmosphere.

Water: Water usage is an item when water is used as a solvent in the extraction process.

Land: No direct impact.

Waste: Residues from extraction if no food, animal feed or associated application is available.

Energy: For the extraction of oil from oilseeds, the energy consumption ranges from 200 to 500 kg steam and from 25 to 50 kWh per ton of oilseed. For extraction of coffee, a typical consumption per ton of dry solids is in the range of 3 to 6 tons of steam and 200 to 300 kWh of electrical power.

Typical specific consumption for the water decaffeinating method are 5 to 10 tons of steam, and 500 to 700 kWh of electrical power. Sugar diffusers consist of very large items of moving equipment. They require substantial electrical power to start the rotation, although less energy is needed once the drums are rotating. Motors are typically in the range of 100 to 350 kW.

Accidents: Spillage of solvent.

Noise: Possible sources of noise are: cooling towers, fans, steam safety valves.

Indicative BAT requirements for extraction:	
1	The main control issues are: • fugitive emissions to air (refrigerants) – see **Section 2.2.4** on page 64 • water use – see **Section 2.4.3** on page 78 • energy efficiency – see **Section 2.7** on page 86
2	No further issues are identified.

2.1.10.2 Centrifugation

Summary of the activities

Centrifugation is used to separate immiscible liquids and solids from liquids by the application of centrifugal forces.

Centrifugation is typically found in the dairy industry for clarification of milk, skimming of milk and whey, concentration of cream, butter oil production, production and recovery of casein, in the cheese industry, lactose and whey protein processing, etc. This processing technique is also used in beverage technology, vegetable and fruit juices, coffee, tea, beer, wine, soy milk, oil and fat processing/recovery, cocoa butter, etc.

Centrifugation is used to separate mixtures of two or more phases, one of which is continuous. The driving force for separation is the difference in density between the phases. By using centrifugal forces the separation process is strongly accelerated. The centrifugal forces are generated by rotating the materials. The force generated depends on the speed and radius of rotation. In raw milk, for example, the skim milk is the continuous phase, the fat phase is a discontinuous phase formed of fat globules with diameters of some micrometres and a third phase can consist of solid particles, hairs, udder cells, straw, etc.

When the differences in density are large and time is not a limiting factor, separation can take place by gravity (known as sedimentation and skimming).

Environmental Impact

Air: Not applicable.

Water: Cleaning.

Land: No direct impacts.

Waste: Not applicable.

Energy: In the case of gravity separators, electrical energy is required for pumping centrifuges and consumes relatively high levels of electricity for driving the equipment.

Noise: The operation of centrifuges may be accompanied by relatively high levels of noise in close proximity of the machines.

Indicative BAT requirements for centrifugation:	
1	The main control issues are: • energy efficiency – see **Section 2.7** on page 86 • noise – see **Section 2.9** on page 94
2	No further issues are identified.

2.1.10.3 Filtration

Summary of the activities

Filtration is used in the food and drink industry to fulfil the following functions:

- to clarify liquid products by the removal of small amounts of solid particles (e.g. wine, beer oils and syrups) –the filtrate is the objective of the operation
- to separate liquid from a significant quantity of solid material, where obtaining the filtrate or cake or both is the overall objective of the operation (e.g. fruit juices)

Filtration equipment operates either by the application of pressure (pressure filtration) to the feed side or by the application of a vacuum (vacuum filtration) to the filtrate side.

Environmental Impact

Air: The air discharge from the vacuum pump.

Water: Depending on the purpose of the filtration operation, the process may result in a liquid waste stream.

Land: No direct impact.

Waste: A filter cake residue may be produced which will require a suitable method of recovery or disposal, e.g. bleaching earth in edible oil refining or kieselguhr (diatomaceous earth) in a brewery.

Energy: Required for application of pressure or vacuum.

Accidents: Not applicable.

Noise: Not applicable.

Indicative BAT requirements for filtration:	
1	The main control issues are: • wastewater treatment – see **Section 2.2.2** on page 48 • waste handling and disposal – see **Section 2.5** on page 83 • energy efficiency – see **Section 2.7** on page 86
2	No further issues are identified.

2.1.10.4 Membrane separation

Summary of the activities

Membrane separation aims at selective removal of water (and solutes) from a solution by using semi-permeable membranes.

Membrane separation is applied for concentration of liquids (for example cheese whey), demineralisation of whey, whey fractionation, or water purification.

Membrane filtration is a pressure-driven filtration technique in which a solution is forced through a porous membrane. Some of the dissolved solids are held back because their molecular size is too large to allow them to pass through and this is dependent upon the types of membranes used. Fractionation of the feed stream occurs, with some molecules being concentrated on the upstream side of the membrane, which is known as the concentrate or retentate, while the smaller molecules pass through the membrane into the permeate stream.

The various membrane filtration techniques, for example used in milk component fractionation, can be characterised by their membrane pore size (the size of the smallest particle that cannot pass through the membrane):

- Microfiltration (MF), pore size range 0.1–5 µm, can be used to remove bacteria from skim milk during the production of ultra clean milks, or for fractionation of skim milk into a casein-rich retentate and a milk serum devoid of casein.
- Ultrafiltration (UF), pore size range 10–100 nm, is applied to both skim milk and whey with the objective of concentrating the respective protein components. Other applications include removal of animal fat from the effluent of a UK meat processing plant.
- Nanofiltration (NF), pore size range 1–10 nm, with selective permeability for minerals, is used predominantly for concentration and pre-demineralisation of whey.
- Reverse osmosis (RO), pore size range 0.1–1 nm, membranes are permeable to water and not minerals and are therefore used for dewatering, concentration of whey or skim milk, polishing NF permeates and recovery of condensate (for example dairy evaporator condensate and brewery wort condensate).

- Electro-dialysis (ED) is membrane separation in the presence of an applied electro-potential. In electro-dialysis, low-molecular-weight ions migrate in an electrical field across cationic or anionic membranes, these membranes being arranged in an alternate manner between the cathode and anode within a stack. Principal application within the dairy industry is for demineralisation of whey.

Environmental Impact

Air: Not applicable.

Water: Handling of permeate (if not re-used), and cleaning.

Land: No direct impacts.

Waste: Handling and disposal of concentrate.

Energy: Membrane separation is a pressure-driven process, so electrical energy is required. In electro-dialysis also electrical energy is required for the transport of ions.

Accidents: Not applicable.

Noise: Not applicable.

Indicative BAT requirements for membrane separation:

1. The main control issues are:
   - wastewater treatment – see **Section 2.2.2** on page 48
   - waste handling and disposal – see **Section 2.5** on page 83
   - energy efficiency – see **Section 2.7** on page 86
2. No further issues are identified.

2.1.11 Cleaning and sanitation

Summary of the activities

Processing equipment and production facilities are cleaned and sanitised periodically, with the frequency varying according to products and processes. The aim of cleaning and sanitation is to remove product remnants from the foregoing process and remove other contaminants and microbes.

Cleaning and sanitation can be carried out in various ways:
- manually
- cleaning-in-place (CIP)
- high-pressure jet cleaning
- foam cleaning

Manual cleaning means that the equipment to be cleaned is taken apart and manually cleaned (brushed) in a cleaning solution. Only mild conditions, with regard to temperature and cleaning agents, can be used.

Cleaning-in-place (CIP) is used especially for closed process equipment and tanks. The cleaning solution is pumped through the equipment and is sometimes distributed by sprayers. The cleaning programme is mostly run automatically. The following steps can be distinguished:
- pre-rinse with water
- circulation with a cleaning solution
- intermediate rinse
- disinfection
- final rinse with water

In automatic CIP systems the final rinse water is often re-used for pre-rinsing. In CIP cleaning high temperatures (up to 90°C) and strong cleaning agents are used.

CIP systems can be much more efficient than manual cleaning but should be designed and used with due consideration to wastewater minimisation. Cleaning programmes controlled by fixed volume sensors tend to use less water than fixed time programmes. Further improvements can be made by the installation of long-life diaphragm valves in CIP systems. (Ref. 8).

In high-pressure jet cleaning, water is sprayed at the surface to be cleaned at a pressure of about 40 to 65 bar. Cleaning agents are injected in the water and moderate temperatures up to 60°C are used. An important part of the cleaning action is due to mechanical effects. Pressure washing reduces water and chemical consumption compared with mains hoses. It is important, however, that a pressure that is both safe and efficient is used. There is some concern in the food industry about the hygiene implications of over-splash and aerosols associated with the use of high-pressure hoses.

A pressurised water ring main is generally preferable to mobile pressure washing machines, which require longer downtime, emit diesel fumes and tend to use more water.

In foam cleaning, a foaming cleaning solution is sprayed on the surface to be cleaned. The foam adheres to the surface. It stays about 10 to 20 minutes on the surface and is then rinsed away with water.

High-pressure jet cleaning and foam cleaning are generally applied for open equipment, walls and floors.

It is common practice for staff involved in clean-up operations to remove floor-drain grates and to flush raw materials and product directly down the drain, believing that a subsequent screen or catchpot will trap all solids. However, when these materials enter the wastewater stream, they are subjected to turbulence, pumping and mechanical screening. This results in the breakdown and release of soluble BOD, along with colloidal and possibly suspended grease solids. Subsequent removal of this soluble, colloidal and suspended organic matter can be far more complicated and expensive than the use of simple screens.

Cleaning agents that are used in the food and drink industry are alkalis (sodium and potassium hydroxide, metasilicate, sodium carbonate), acids (nitric, phosphoric, citric and gluconic acids), composed cleaning agents containing chelating agents (EDTA, NTA, phosphates, polyphosphates, phosphonates) and surface-active agents.

Sanitation chemicals and techniques

Oxidising biocides oxidise the bacterial cell walls in order to prevent replication. They rely on the use of strong oxidising agents such as chlorine/bromine, ozone and hydrogen peroxide. The use of chlorine compounds (chlorine gas, chlorine dioxide, sodium hypochlorite) relies upon the formation of hypochlorous acid (the active biocide) in aqueous solution. Bromine-based biocides are also becoming more prevalent in industrial applications due to the hypobromous acid species dissociating at a higher pH than the equivalent chlorine-based compounds.

The main disadvantage of chlorine-based chemistry is the ability of chlorine to react with a wide number of other compounds and so actually reduce the “effective” chlorine dose rate.

The use of ozone is also increasing for disinfecting purposes.

Non-oxidising biocides operate by chemically altering the cell structure in order to prevent bacterial cell replication. These are becoming common, and examples are quaternary ammonium salts and formaldehyde/glutaraldehyde.

UV light is perhaps the most significant advancement in disinfection technology over the past 10 years. UV light at 254 nm is readily absorbed by the cellular genetic material within bacteria and viruses, which prevents the cell from replicating. The main advantages of UV disinfection over other techniques include no storage or use of dangerous chemicals, the absence of harmful by-products (no organohalogens) and is a simple technology with relatively low capital and operating costs.

The dose rate is measured in milliwatts per square centimetre multiplied by the contact time in seconds. The actual dose is dependent on the transmittance (i.e. compounds which can absorb and reduce UV light effectiveness) of the wastewater stream. UV light also causes an immediate reaction and therefore does not impart any residual effect, with treated waters liable to re-infection.

The main disadvantage of UV disinfection is that a direct line of sight must be maintained between the lamp and the bacteria/virus. Any appreciable levels of suspended solids (hence decreasing transmissivity) will actually shield the bacteria and prevent their disinfection.

Environmental Impact

Air: Not applicable.

Water: Wash waters will contain remnants of cleaning agents, product rinsed from the system and removed from the equipment that is cleaned.

Land: No direct impacts.

Waste: Not applicable.

Energy: Cleaning is commonly carried out at elevated temperatures utilising steam. Pre-clean systems, for example vacuum transfer, blowers and pigging systems, require power and compressed air.

Accidents: Spillage of cleaning chemicals. Leakage from effluent system. Overloading of effluent treatment system.

Noise: Not applicable.

Indicative BAT requirements for cleaning and sanitation: (Sheet 1 of 2)

1 The single most important factor in reducing wastewater strength in this sector is the adoption of dry clean-up techniques. Wherever possible raw materials and product should be kept out of the wastewater system.

EXAMPLE Dairy sector

Treating spills of curd, yoghurt or ice cream mix as solid waste rather than washing them down the drain.

2 Taking this as the starting point, the Operator should demonstrate that procedures are in place to achieve this and then ensure that appropriate cleaning procedures are in place and should include such measures as the following:

3 Equipment design:

- wherever practicable, process lines and operations that cause excessive spillage of material onto the floor should be modified to eliminate or reduce the problem (ETBPP GG154 – Ref. 8)
- removing as much residual material as possible from vessels and equipment before they are washed
- ensuring that drains are equipped with catchpots
- that the catchpots are in place during cleaning (for example by installing lockable catchpots);
- optimisation of water pressure at jets, nozzles and orifices
- automatic water supply shut off on trigger operated spray guns or hoses

Indicative BAT requirements for cleaning and sanitation: (Sheet 2 of 2)

4 Good housekeeping:
- installing trays to collect waste as it falls to the floor
- sweeping, shovelling or vacuuming spilt material rather than hosing it down the drain
- making sure suitable dry clean-up equipment is always readily available
- providing convenient, secure receptacles for the collected waste
- optimisation of cleaning schedules
- matching cleaning cycle durations to the vessel size
- product scheduling to minimise numbers of product changes and subsequently cleaning between products

5 Management of manual cleaning:
- procedures to ensure that hoses are only used after dry clean-up
- trigger controls should be used on hand-held hoses and water lances to minimise the use of washdown water
- use of high-pressure/low-volume systems

6 Cleaning chemicals usage:
- The Operator should ensure that staff (and contract cleaners) are trained in the handling, making up and application of working solutions, for example, not setting the concentration of the chemical agent too high and avoiding the overuse of chemicals, particularly where manual dosing is used.

7 Cleaning-in-place (CIP):
- dry product removal before the start of the wash cycle by gravity draining, pigging or air blowdown
- pre-rinse to enable remaining product to be recovered for re-use or disposal
- use of turbidity detector to maximise product recovery
- optimal CIP programme for the size of plant/vessel and type of soiling
- automatic dosing of chemicals at correct concentrations
- internal recycling of water and chemicals
- recycle control on conductivity rather than time
- continuous cleaning of recirculated solutions
- water-efficient spray devices

8 Sanitisation:
- the Operator should justify the use of organohalogen-based oxidising biocides over the alternatives, for example ozone and UV light

9 Recycling of water and recovery of cleaning chemicals – see **Section 2.4.2.1** on page 76.

2.2 Emissions control

2.2.1 Abatement of point source emissions to air

Nature of the emissions

The nature and source of the emissions expected from each activity is given in previous sections and the inventory of emissions should be confirmed in detail in the Application.

those tabulated below in **Table 2.5**.

Table 2.5: Nature of emissions

Activity	Pollutant			
	VOC	Odour	Particulate	SOx, NOx
Receiving and handling of raw materials (**Section 2.1.2** on page 16)		Yes	Yes	
Preparation of raw materials				
Dry cleaning			Yes	
Peeling	Yes	Yes		
Mixing (of dry powders)			Yes	
Extrusion	Yes	Yes		
Heat processing using steam or water				
Blanching	Yes	Yes		
Evaporation	Yes	Yes	Yes	
Pasteurisation/sterilisation		Yes		
Heat processing using hot air				
Drying	Yes	Yes	Yes	
Baking and roasting		Yes		Yes
Frying	Yes	Yes		Yes
Grinding and milling			Yes	
Solvent extraction	Yes			
Combustion plant				Yes
Effluent treatment systems		Yes		

The distinction between emissions of VOC/odour and particulate/odour are not always clear. Where odour (see **Section 2.2.6** on page 67) may be an issue, the cause will typically be emissions of VOCs (sometimes at low concentrations). Measures taken to prevent or reduce VOCs might also lead to a reduction in odour and similarly for particulate.

Indicative BAT requirements for control of point source emissions to air: (Sheet 1 of 2)

1 The benchmark values for point source emissions to air listed in **Section 3.2.1** on page 108 should be achieved unless alternative values are justified and agreed with the Regulator.

2 The main chemical constituents of the emissions should be identified, including VOC speciation where practicable.

3 Vent and chimney heights should be assessed for dispersion capability and an assessment made of the fate of the substances emitted to the environment (see **Section 4** on page 122).

Control of visible particulate plumes

4 Even where particulate benchmarks are already met, the aim should be to avoid visible emissions. However, because plume visibility is extremely dependent on the particle size and reflectivity, the angle of the light, and the sky background, it is accepted that, even when BAT is employed and very low emissions are being achieved, some plumes may still be visible under particular conditions.

Control of visible condensed water plumes

5 The need to minimise water vapour plumes should always be considered as, in addition to possible local visual amenity issues, in severe cases, plumes can cause loss of light, fogging, icing of roads, etc. High moisture content can also adversely affect plume dispersion so, where practicable, water content of the exhaust stream should be reduced. Ideally, the exhaust should be discharged at conditions of temperature and moisture content that avoid saturation under a wide range of meteorological conditions, including cold damp conditions.

6 The use of **primary energy** to reduce a plume simply because it is visible is not considered BAT. However, it may be appropriate to use **waste or recovered heat**, for example, heat in a gas stream prior to wet scrubbing can be used for re-heating the exhaust stream after scrubbing by means of a gas-gas heat exchanger. The use of energy for exhaust gas re-heat should be balanced against the benefits gained.

7 The Operator should provide the identification of the main chemical constituents of the emissions (particularly for mixtures of VOCs) and assessment of the fate of these chemicals in the environment (refer to **Section 2.2.6** on page 67, Odour – identification of constituent components may not always be practicable for VOCs where concentrations are low).

8 Air movements around loading/unloading and transfer points for dry powders and grain, etc., are a significant source of dust emissions. Orientation of the plant and installation of roll down or bi-fold doors should reduce wind effects.

9 Enclosure

10 Generally, the volume of air involved determines the degree of difficulty in dealing with air emissions. The volume of air has implications not only for the final size of abatement plant but also for the associated equipment such as fans, ducting, pressure losses, etc. Optimum containment of odorous or polluted air is therefore important in either eliminating the need to treat the air or minimising the amount (and consequently cost) of the abatement technology. Enclosure of specific units identified as being a source of pollution should be implemented to reduce air volumes requiring abatement (see **Figure 2.1** and **Figure 2.2**).

11 The Operator should maintain a plan for the reduction of emissions to air, in particular odourous VOCs, combustion gases and particulates. The plan should be revised annually and submitted to the regulator.

Indicative BAT requirements for control of point source emissions to air: (Sheet 2 of 2)

Figure 2.1: Example of enclosure of a food processing unit

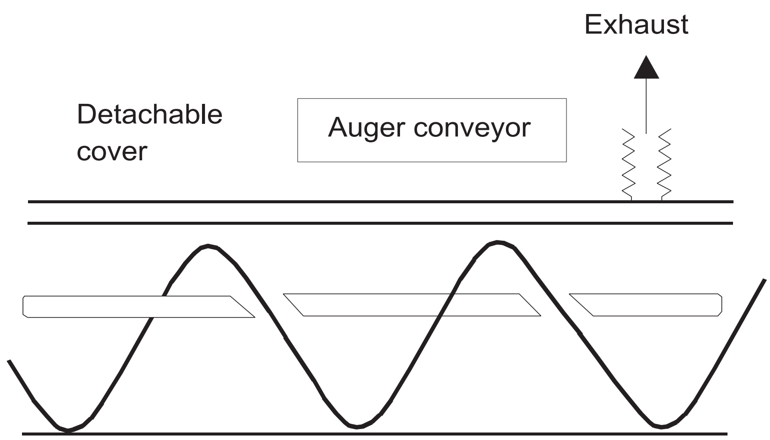
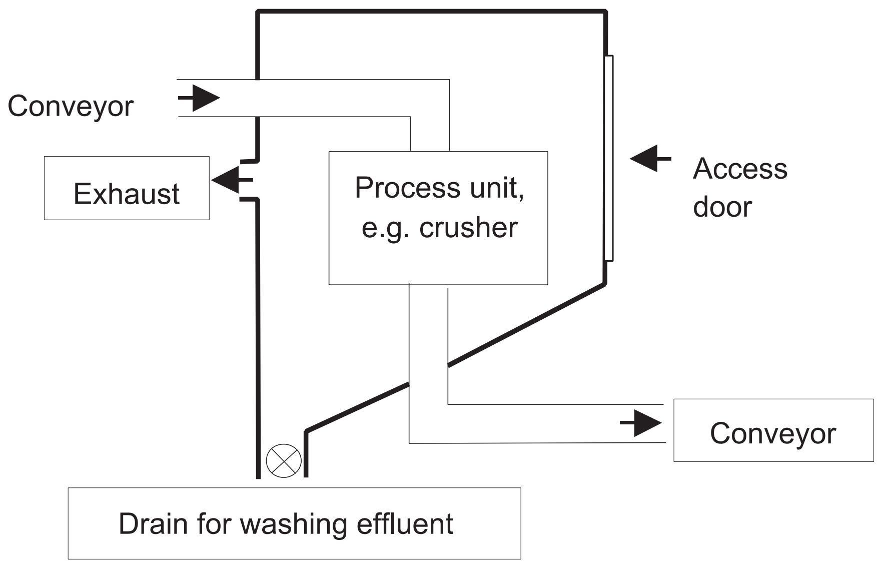


Figure 2.2: Example of enclosure of a conveyor system (also see **Section 2.1.2** *on page 16*



Processes using heat

12 Energy-efficient techniques, such as heat recovery systems on indirect fired ovens and fryers, utilise exhaust air for pre-heating and also recycle the exhaust gas to the heater. The combustion of the recycled exhaust gas should be considered as a technique for reducing NOx emissions in the release to atmosphere.

Table 2.6: Abatement options for specified pollutants

Activity	Abatement options for specified pollutants (Note 3)			
	VOC	Odour	Particulate	SOx, NOx,
Receiving and handling of raw materials (Note 1) (Note 2)			Cy, FF	
Preparation of raw materials				
Dry cleaning			Cy, FF	
Peeling	C, TO, BO, CO			
Mixing (of dry powders)			Cy, FF	
Extrusion	C, TO, BO, CO			
Heat processing using steam or water				
Blanching	C, TO, BO, CO			
Evaporation			Cy, FF	
Pasteurisation/sterilisation		Ad, C, TO, BO, CO		
Heat processing using hot air				
Drying	C, TO, BO, CO		Cy, FF	
Baking and roasting		Ab, Ad, C, TO, BO, CO		See "Processes using heat" on page 46
Frying	Ab, Ad, C, TO, BO, CO			See "Processes using heat" on page 46
Grinding and milling			Cy, FF	
Solvent extraction	Ad, C, TO, BO, CO			
Effluent treatment systems		Ad, C, TO, BO, CO		

Notes:

1. In addition to enclosure, emissions from conveyor systems should be prevented by minimising free-fall distances and reducing velocities.

2. Gravity unloading of, for example, grain from the delivering vehicle to a bunker can give rise to significant dust emissions. Using a technique such as an enclosure or a choke flow system should be employed as appropriate to reduce these emissions.

3. See **Table 2.7** for more information on abatement options.

Key: Ab, Absorption; Ad, Adsorption; C, Condensation; TO, Thermal oxidation; BO, Biological oxidation; CO, Catalytic oxidation; Cy, Cyclones; FF, Fabric filters.

Table 2.7: Abatement options information

Key	Name	Comment
Ab	Absorption	Suitable for high-flow, low-concentration (1–200 mg/m^3 VOC), low-temperature gas streams, where the pollutant is chemically reactive (or soluble in the case of VOC contaminants). A common use is the treatment of contaminated ventilation air. Water supply and effluent disposal facilities must be available.
Ad	Adsorption	The humid nature of many food waste streams counts against carbon adsorption as a technology because the polar nature of the common adsorbents will preferentially adsorb water vapour.
C	Condensation	Air streams from, for example, cookers and evaporators can contain volumes of water vapour, which are much greater than the volume of air and non-condensables. If the air stream is to be abated by thermal oxidation, the required energy to oxidise a wet stream containing 1 kg water/kg dry air (at 100°C) is approximately 2.6 times the energy requirement for the equivalent dry stream. Condensation is a useful pre-treatment, which, in addition to reducing the fuel requirement and the overall size of oxidiser, will also provide abatement.
TO	Thermal oxidation	For Food and Drink sector applications this will usually require the addition of supplementary fuel to support the combustion process. Even for VOC abatement purposes it is unlikely that any food applications will be autothermal. The Operator can offset the cost of the supplementary fuel when there is a requirement elsewhere on-site for the waste heat that is generated.
BO	Biological oxidation	Typically applied to air streams with VOC < 1500 mg/m^3. Requires a long residence time, typically > 30 s. For a gas flow of 150,000 Nm^3/h, a reactor volume of approximately 1250 m^3 would be required. The available surface area may be the limiting factor. Variability in gas flow rate, gas composition in terms of available organic constituents, pH, temperature and humidity may be difficult to manage.
CO	Catalytic oxidation	Suitable for air flow range 150–70,000 m^3/h. The catalyst has an upper temperature limit and an increase in VOC concentration may increase the temperature beyond the limit.
Cy	Cyclones	Relatively cheap and reliable. Not effective against particle sizes <10 um. For example, exhaust from a spray dryer is loaded with dried powder, which is typically passed through a cyclone. The outlet air from the cyclone may contain dust particles up to 200 mg/m^3, which may require additional measures, for example fabric filters.
FF	Fabric filters	Collected dust can be returned to the process or used in animal feed. May not be suitable for some applications. For example, drying baby food has been associated with mould contamination.

2.2.2 Abatement of point source emissions to surface water[1] and sewer

The nature and source of the emissions to surface water or sewer expected from each activity is given in previous sections and the inventory of emissions should be confirmed in detail in the Application.

[1] Surface waters means controlled waters (Water Resources Act 1991) but excludes groundwaters (waters contained in underground strata) which are covered in **Section 2.2.3** on page 63.

In the PPC Regulation 2(2), references to an emission into water include an emission into a sewer (within the meaning of Section 219(1) of the Water Industry Act 1991). Consequently, pollution control measures can be applied to discharges to sewer.

As noted before, the primary consideration should always be to prevent releases of harmful substances to the aquatic environment, whether releases are direct or via a sewage treatment works, and only where prevention is not practicable should the release be minimised or reduced to the point where the emission is incapable of causing significant harm.

A wide variety of techniques is available for the control of releases to water or sewer, and the BREF on Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector (see **The Pollution Prevention and Control Act (1999) (www.hmso.gov.uk).**) should be consulted. Section 3.3 of the BREF has details of available water treatment techniques and Section 4.3.1 contains recommendations on what might constitute BAT for a variety of treatment techniques for releases to water.

In addition to the BREF and the techniques noted below, guidance on cost-effective effluent treatment techniques can be found in **Releases to water references**. This includes IPC Technical Guidance Note A4 which summarises techniques of particular relevance to the batch organic chemicals sector.

Waste water can arise from the process, from storm water, from cooling water, from accidental releases of raw materials, products or waste materials, and from fire-fighting. These should all be taken into account when determining the Application.

2.2.2.1 Nature of the effluent

Summary of the activities

The nature of the emissions from each example activity is given in **Section 2.1.2** on page 16 to **Section 2.2.1** on page 44. A number of other general sources are identified in **Section 2.4.3** on page 78. Others include:

- blowdown from steam boilers
- once-through cooling water or bleed from closed loop cooling water systems
- condensate from small cooler units
- backwash from regeneration of water treatment plant
- freezer defrost water
- stormwater run-off

Most of the water not used as an ingredient ultimately appears in the wastewater stream. In the fruit and vegetable subsector, for example, in the order of 10 m^3 of wastewater is generated for every tonne of raw material processed. Wastewater flow rates may be very variable on a diurnal, weekly or seasonal basis. Wastewater from the Food and Drink sector is notable for its extreme variability in composition. The wastewater profile is largely dependent on production patterns and when cleaning, which is often the largest water use, takes place. In some categories (e.g. sugar beet) processing takes place on a campaign basis and there will be little or no wastewater for part of the year.

Substantial reductions in the volume of wastewater generated in this sector can be achieved through water use (see **Section 2.4.3** on page 78) and tertiary treatment methods (see “Tertiary treatment” on page 56). ***It is, however, recognised that water conservation measures do not lead to unsatisfactory levels of cleanliness, hygiene or product quality.***

Wastewater from the Food and Drink sector is largely organic and biodegradable. However, effluent may contain some substances that may have an adverse effect on treatment plants or receiving waters. These include:

- salinity where large amounts of salt are used (e.g. pickling, cheese making)
- pesticide residues
- residues and by-products from the use of chemical disinfection techniques
- some cleaning products

Typically food processing wastewater is high in COD and BOD compared with other sectors and 10–100 times stronger than domestic sewage. There are, of course, exceptions and in some cases the BOD may be as low as 100 mg/l. The total mass of BOD is directly associated with levels of product in the wastewater and is therefore an indication of inefficient processing. The BOD contents of the main food constituents are as shown below in **Table 2.8**.

Table 2.8: BOD contents of the main food constituents

Constituent	kg BOD/kg food
Carbohydrate	0.65
Fats	0.89
Protein	1.03

Whilst relatively high levels are inevitable in many cases, preventing raw materials and wastes from unnecessarily entering the wastewater system and optimising chemical use can make a significant difference. The excessive or inappropriate use of cleaning chemicals may also contribute to high BOD and COD levels. Surfactants and common acid detergents have a BOD in the order of 0.65 kg/kg of chemical.

Suspended solids (SS) concentrations in food processing wastewaters vary from negligible to as high as 120,000 mg/l. Levels of several thousand mg/l are not uncommon.

Wastewater from the dairy, meat, fish, baking and edible oil extraction subsectors and from the manufacture of oily foods such as margarine and salad dressings typically have high concentrations of fats, oils and greases (FOG). FOG may be “free”, i.e. physically separate from the aqueous phase, or emulsified.

Food processing wastewaters vary from the highly alkaline (pH 11) to the highly acidic (pH 3.5). Factors affecting wastewater pH include:

- the natural pH of the raw material
- pH adjustment of fluming water to prevent raw material deterioration
- use of caustic or acid solutions in processing operations
- use of caustic or acid solutions in cleaning operations
- acidic waste streams (e.g. acid whey)
- acid-forming reactions in the wastewater (e.g. high yeast content wastewater, lactic and formic acids from degrading milk content)
- nature of raw water source (hard/soft)

Inadequately contained spills of acid or alkaline materials and Operator error can result in excessively high or low pH that causes problems for wastewater treatment.

The presence of pathogenic organisms in the wastewater may be a consideration, particularly where meat or fish are being processed.

In addition to the various BREFs, guidance on cost-effective effluent treatment techniques can be found in **Water efficiency references:**.

Indicative BAT requirements for effluent treatment: (Sheet 1 of 10)

General water treatment techniques

1 The following general principles should be applied in sequence to control emissions to water:

- water use should be minimised and wastewater reused or recycled (see **Section 2.4.3** on page 78)
- contamination risk of process or surface water should be minimised (see **Section 2.2.5** on page 66)
- wherever possible, closed loop cooling systems should be used and procedures in place to ensure blow down is minimised
- where any potentially harmful materials are used measures should be taken to prevent them entering the water circuit

2 Consideration should be given to the use of filtration/osmosis or other techniques which allow the effluent water to be cleaned for release or, preferably, for return to the process. Particular consideration should be given to the fate of the concentrated residues of such techniques. These can often be returned to furnaces, evaporated, solidified, sent for incineration etc. Tankering of such residues off the site as waste, simply transfers the problem to another place unless they are sent to a facility with the genuine ability to recycle the materials.

3 If the pollutants in the wastewater are all readily biodegradable or the effluent contains only materials which are naturally occurring in much larger quantities in the receiving water, there may be justification for filtration/osmosis or similar techniques not being considered appropriate.

4 Where prevention is not possible, the emissions benchmarks given in **Section 3** on page 106, should be achieved.

5 Where effluent is treated off-site at a sewage treatment works the above factors still apply. In particular, it should be demonstrated:

- the treatment provided at the sewage treatment works is as good as would be achieved if the emission were treated on-site, based on reduction of load (not concentration) of each substance to the receiving water. (The **IPPC Environmental Assessments for BAT** software tool will assist in making this assessment.)
- that action plans are appropriate to prevent direct discharge of the waste-waters in the event of sewer bypass, (via storm/emergency overflows or at intermediate sewage pumping stations) - for example, knowing when bypass is occurring, rescheduling activities such as cleaning or even shutting down when bypass is occurring.
- that a suitable monitoring programme is in place for emissions to sewer.

6 There must be an understanding of the main chemical constituents of the treated effluent (including the make-up of the COD and the presence of any substances of particular concern to the aqueous environment). The fate of these chemicals in the environment should be assessed.

7 As a minimum, all emissions should be controlled to avoid a breach of water quality standards (see **Section 3.2** on page 108 and **Section 4.1** on page 122), but where another technique can deliver better results at reasonable cost it will be considered BAT and should be used (see **Section 1.1** on page 1). Unless self-evident, calculations and/or modelling to demonstrate this should be carried out as part of the Application (in response to its Section 4.1questions)..

Indicative BAT requirements for effluent treatment: (Sheet 2 of 10)

8 The Operator should maintain a plan for the prevention or reduction of point source emissions to water and land. This should include, but is not limited to, the measures described below. The Operator should justify where any of the measures are not employed.

9 The Application should include:

- a description of the wastewater treatment system for the activity
- justification for not cleaning the effluent to a level at which it can be re-used (for example by ultrafiltration where appropriate)
- identification of the toxicity of the treated effluent
- where there are harmful substances or levels of residual toxicity, the techniques proposed to reduce the potential impacts
- the measures to increase the security with which the required performance is delivered

10 The plan should be reviewed annually and submitted to the regulator.

11 Ultimately, surplus water is likely to need treatment to meet the requirements of BAT (and statutory and non-statutory objectives). Generally effluent streams should be kept separate as treatment will be more efficient. However, the properties of dissimilar waste streams should be used where possible to avoid adding further chemicals, e.g. neutralising waste acid and alkaline streams. Also biological treatment can occasionally be inhibited by concentrated streams and dilution, by mixing streams, can assist treatment.

12 Systems should be engineered to avoid emissions to water by-passing the treatment plant.

13 With regard to BOD, the nature of the receiving water should be taken into account. However, in IPPC the prevention or reduction of BOD is also subject to BAT, and further reductions which can be made at reasonable cost should be carried out. Furthermore, irrespective of the receiving water, the adequacy of the plant to minimise the emission of specific persistent harmful substances must also be considered. Guidance on treatment of persistent substances can be found in “Direct Toxicity Assessment for Effluent Control: Technical Guidance (2000) UKWIR 00/TX/02/07”.

Water treatment for the Food and Drink sector

14 Irrespective of the type of treatment provided, all Operators should assess the possibility of recycling the treated wastewater in a partially or fully closed system (see **Section 2.4.3** on page 78). The Operator should justify the choice and performance of the effluent management system for the plant against the factors give in **Table 2.9** on page 60.

Preliminary techniques

15 Wherever possible raw materials and product should be kept out of the wastewater system (see **Section 2.4.3** on page 78) . After dry clean-up techniques, the next measure is the installation of drain catchpots and screens. Where gross FOG is found in wastewater, drainage systems should be equipped with appropriately designed grease traps and gratings to prevent sewer blockages. It is particularly important that these are regularly inspected, emptied and maintained, with cleaning taking place in an area draining to the foul sewer.

Indicative BAT requirements for effluent treatment: (Sheet 3 of 10)

Flow balancing and equalisation

16 Wastewater equalisation or balancing refers to either the combining of various streams arising from processing or the short-time accumulation of wastewater to minimise the variability of flow rates and composition feeding forward to the effluent treatment processes. Equalisation equipment consists of a holding tank or pond and pumping equipment that is designed to reduce the fluctuations in wastewater flow through the effluent treatment plant. The tanks should have capacity to provide uniform flow throughout the typical 24 hour cycle period (typical hydraulic retention times of 6–12 hours).

17 Flow equalisation has the advantage that subsequent treatment systems may be smaller (since they are designed for the average flow and not the peak) and will not be subjected to shock loads or variations in the feed rate. Equalisation allows the best use of the complementary nature of existing chemicals within the individual wastewater streams to enable the final wastewater to comply with regulated limits. For example, where individual unit operations are batch and discharges are intermittent, this may result in considerable variations in pH or strength of the final wastewater. Measures can include the balancing of acid and alkali streams, such as spent ion exchange regenerants, or the dilution of high-strength streams with lower strength streams.

18 Buffer storage or balancing tanks should normally be provided to cope with the general variability in flow and composition of wastewaters, or to provide corrective treatment, e.g. pH control, chemical conditioning. They may also require heating and/or agitation to prevent FOG separation. If no balancing is provided, the Operator should show how peak loads are handled without overloading the capacity of the wastewater treatment plant

Diversion tanks

19 The Operator should describe appropriate contingency measures for accidental discharges from the processes that could prove detrimental to the wastewater treatment plant.

20 If a diversion tank is not provided, the Operator should show how potentially detrimental streams are handled without adversely affecting the wastewater treatment plant.

21 A diversion tank capable of receiving typically 2–3 hours of peak flow should be allowed for. The wastewater streams should be monitored upstream of the wastewater treatment plant in order to provide automatic diversion to the diversion tank. The diversion tank should be linked back to the balance tank or primary treatment stage so the out-of-specification liquors can be gradually introduced back into the wastewater stream. Alternatively, provision should be made to allow for the disposal off-site of the calamity tank contents.

22 The objective of this stage is the removal of particulate solids or gross contaminants such as fats, oils and greases (FOG). The preferred solution will depend on the specific location and wastewater characteristics. Typical primary treatment techniques include screening, equalisation, sedimentation, air flotation and centrifugation.

Primary treatment

23 Reduction of organic solids and fats, oils and greases (that contribute to the total BOD (organic) load) will reduce the organic loading onto the secondary treatment stage, and hence will improve the performance and reduce the capital and running costs of the biological treatment plant. It also provides protection for all subsequent treatment stages, i.e. solids removed at the primary stage tend to be the heavier particulates that can cause abrasion, blocking and general wear and tear hence increasing maintenance costs and reducing the lifespan of the installation.

Indicative BAT requirements for effluent treatment: (Sheet 4 of 10)

Screens

24 Interception of the waste materials by various types of screens should be the first step in decreasing the solids loading of the wastewater. Drains and grates in operational areas should be fitted with catchpots.

25 Subsequent screens should be placed on wastewater streams as near to the process end of the drains as possible.

26 The main types of screens used are static (brushed or run-down screens) coarse or fine, vibrating and rotary screens.

Principles of operation

27 The Operator should ensure that screening equipment is correctly maintained. For example, regular observation is required to ensure that there is no physical damage to the screens and that the solids removal/backwash is operating effectively.

28 The Operator should ensure that the screening capacity is large enough to take account of predictable variations in flow rates during day-to-day operations and due to seasonal variations.

29 Overloading may be a factor where surface water drains are connected to the wastewater drainage system above the screening equipment. Subsequent re-routing of the surface water drains after the installation of the screening equipment should take account of the increased loading during wet weather.

30 Flow equalisation preceding screening equipment may be needed to avoid overloading and by-passing the screen.

31 Blinding of screens is a common problem and, if occurring regularly, consideration should be given to increasing the mesh size or improving the cleaning regime. Most screen manufacturers have different mesh sizes available that can be changed relatively easily.

Settlement

32 Settlement involves settling by gravity, and is commonly used in the Food and Drink sector for the removal of particulate and colloidal solids, and flocculent suspensions. Settlement is carried out in clarifiers that are specifically designed with an inlet, outlet, settling zone and sludge blanket (or sludge zone). Sludges liberated from a settlement stage are typically around 1% dry solids content.

33 It should be noted that some wastewaters contain substances that may interfere with the settling of suspended solids; for example, wastewater from citric fruit processing contains pectic substances that may do this.

Air flotation

34 Air flotation is a physical solids separation process relying upon the chemical conditioning of the suspended solids to form a flocculated structure that can be floated to the surface of a reactor by introducing fine bubbles of air.

35 Flotation is used when gravity settlement is not appropriate, for example when:

- the particulates have poor gravity settling characteristics
- the density difference between the suspended particles and water is too low
- there is a space constraint at the site
- oil and grease are to be removed
- recovery of material is required

Indicative BAT requirements for effluent treatment: (Sheet 5 of 10)

36 Dissolved air flotation (DAF) is most widely used because of its effectiveness in removing a range of solids. Other flotation techniques include the following:

- Vacuum flotation occurs in a similar manner to DAF, except that the air is dissolved at atmospheric pressure and a sub-atmospheric vacuum is drawn to release the air.
- Induced air flotation occurs when fine air bubbles are drawn into the liquid via an induction device, such as a venturi or orifice plate.
- Electroflotation occurs when electrodes placed in the liquid create hydrogen and oxygen bubbles.

37 The choice of chemicals used for coagulation and flocculation will depend upon the intended disposal route for the DAF sludges. Should the sludges be recoverable as a by-product for possible animal feed, then the chemicals used must be of low toxicity. Typically, sludges recovered from a DAF cell would be in the region of 3–4% dry solids content.

Centrifuges

38 There are three main types of centrifuge available:

- solid bowl
- basket
- disc–nozzle

39 The disc–nozzle configuration is primarily used for liquid/liquid separation.

40 The objective of this stage is the removal of biodegradable materials (BOD) which can be achieved by degradation or by adsorption of pollutants to the organic sludge produced. The latter mechanism will also remove non biodegradable materials such as heavy metals. The preferred solution will depend on the specific location and wastewater characteristics.

41 The basic alternatives are aerobic and anaerobic biological systems (see **Table 2.10** on page 61). There are many designs of each.

42 The Operator should justify the choice and performance of the secondary treatment plant against the following factors.

43 Anaerobic treatment alone would not achieve a final effluent quality high enough for discharge to a watercourse. Anaerobic installations should be followed by an aerobic system as the latter should ensure that the final effluent is well aerated to assist in the breakdown of the remaining BOD. Whereas anaerobic treatment is not viable for low-strength effluents, aerobic processes can be used for both high- and low- strength effluent.

44 There should be specific procedures for nutrient and other chemical dosing which ensure that the optimum balance of added nutrients is maintained, minimising both releases of nutrients and the occurrence of bulking.

45 Food processing wastewater is often deficient in nitrogen and/or phosphorus needed to support biological activity during treatment. The ideal BOD/nitrogen/phosphorus ratio is about 100/ 5/1. Excessive levels of phosphorus can also occur, particularly where large quantities of phosphoric acid are used in cleaning. If such wastewater becomes anaerobic during treatment, there is a risk that phosphate-containing constituents could release phosphorus to the final effluent. The use of nitric acid in a process will produce a similar effect, increasing the levels of ammonia in the wastewater.

46 The Operator should have procedures in place to deal with bulking when it occurs including reducing load if necessary.

Indicative BAT requirements for effluent treatment: (Sheet 6 of 10)

47 The Operator should confirm whether ammonia is present as a breakdown product, provide evidence of the levels and state whether de-nitrification is needed.

48 The Operator should quote the residence time, the sludge age and the operating temperature, and justify these parameters in terms of the breakdown of the more resistant organic substances.

Secondary treatment

49 After a biological plant, solids removal should be provided. This can be by secondary clarifier, but where space permits, systems with the benefit of large, post-treatment lagoons gain excellent protection against bulking or other problems. This should be designed in where space permits.

50 Post-treatment lagoons should be designed to enable easy de-sludging. The frequency of de-sludging should be appropriate to the process, but should be carried out on a regular basis.

51 Techniques such as MBR (membrane bioreactor) do not require clarification and therefore have a much smaller space requirement. This is also true of SBR (sequencing batch reactor) where clarification can take place inside the same vessel as the reaction.

52 Common operational problems experienced with anaerobic treatment processes are as follow:

- Lack of macro-nutrients. BOD/N/P ratios should normally be maintained at 100/5/1.
- pH. In the reactor, the pH should be maintained at 6.8–7.5
- Temperature. In the reactor, the optimum temperature for mesophilic bacteria is 35–37×C.
- Lack of micro-nutrients. Minimum quantities of micro-nutrients should be maintained, especially for Fe, Ca, Mg and Zn, according to the specific process employed.
- Significant quantities of fats, oil (especially mineral oil) and greases should be removed prior to the reactor.
- Physical blockage of the reactor inlet pipework. Effective screening and primary treatment are essential.
- Overloading. Care should be taken to ensure that the original hydraulic and loading design rates do not exceed the manufacturer's recommendations.

53 Whichever design of primary and secondary plant is used, it should be able to achieve the benchmarks. See **Table 2.10** on page 61 for a summary of aerobic and anaerobic treatment processes.

Tertiary treatment

54 Tertiary treatment refers to the recycling of water back into the factory either as process water or as wash water and any process that is considered a "polishing" phase after the secondary treatment techniques up to and including disinfection and sterilisation systems.

55 There are two categories of tertiary treatment processes:

Macrofiltration

56 Macrofiltration describes the tertiary removal of suspended solids, usually through the use of sand filtration or mixed media (e.g. sand/anthracite blends). Filters may be either gravity filters or pressure filters.

57 More specialised types of filtration media, such as granular activated carbon (GAC), are used to remove certain chemicals, tastes and odours. GAC works by adsorbance of the contaminants onto and within the carbon granules. In time the carbon will need regeneration, which is usually carried out by incineration.

Indicative BAT requirements for effluent treatment: (Sheet 7 of 10)

58 There are now a number of constantly "self-cleaning" sand filters available which have proven to be extremely effective at polishing suspended solids from the final effluent.

Membrane techniques

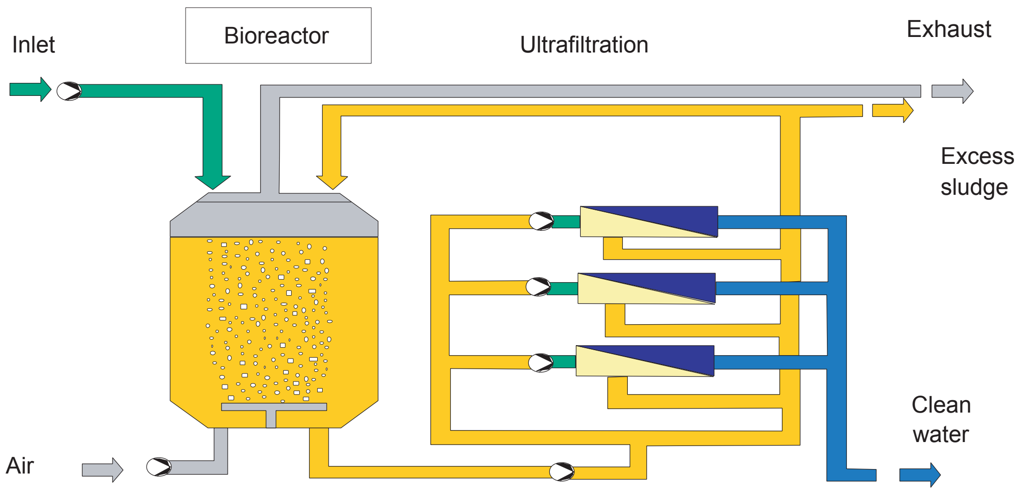
59 Membrane techniques is a term applied to a group of processes that can be used to separate suspended, colloidal and dissolved solutes from a process wastewater. The technology is applied for example in the dairy industry to recover milk as a useable by-product from waste-waters. Membrane filtration processes use a pressure-driven, semi-permeable membrane to achieve selective separations. Much of the selectivity is established by designations relative to pore size. The pore size of the membrane will be relatively large if precipitates or suspended materials are to be removed (cross-flow microfiltration), or very small for the removal of inorganic salts or organic molecules (ultrafiltration or reverse osmosis).

60 During operation, the feed solution flows across the surface of the membrane, clean water permeates through the membrane, and the contaminants and a portion of the feed remain. The clean or treated water is referred to as the permeate or product water stream, while the stream containing the contaminants is called the concentrate, brine, reject, or sludge returns. The Operator should have a strategy for dealing with the concentrate.

61 The technologies employed depend on the level of "filtration" that is actually required, and generally consist of:

- microfiltration
- ultrafiltration
- nanofiltration
- reverse osmosis

Figure 2.3: Example of membrane bioreactor (MBR) at a dairy



Indicative BAT requirements for effluent treatment: (Sheet 8 of 10)

62 See **Table 2.11** on page 62 for an MBR - Activated Sludge (AS) comparison.

Sludge treatment and disposal

63 Sludge treatment and disposal are quite often left until last when companies consider on-site effluent treatment. However, in terms of capital expenditure and operating costs, sludge treatment and disposal can prove as expensive (if not more so) than the rest of the effluent treatment plant. Whilst environmental legislation continues to limit the disposal options available, or significantly increase the associated cost, the management and disposal of solid waste will remain as one of the most fundamental issues facing the effluent plant operator. The disposal of sludge by means of landspreading (see **Section 2.6** on page 84) may also be disrupted by weather conditions, i.e. a period of heavy rain, which means that suitable storage capacity may be a factor.

64 Before considering on-site sludge treatment and potential disposal routes, the Operator should be more concerned with how to reduce the cost of disposal, and this is generally associated with a reduction in sludge volume rather than the optimisation of an on-site treatment process.

65 It has already been seen in “Primary treatment” on page 53 how a large amount of solids can be removed from the influent by the efficient use of primary treatment processes (screenings, DAF, settlement, etc.). It is assumed that any product recovery that can take place has already been achieved, and as such, any solid material that cannot be recovered must be disposed of in an environmentally acceptable way and the costs absorbed into the overall running cost.

66 In addition, any aerobic biological treatment process employed will, by its very nature, convert a high proportion of the organic load to new bacteria cells, the wasting of which (as surplus activated sludge) will further contribute to the solid material that requires disposal. The quantity of sludges produced for disposal from an anaerobic system would be significantly less.

Sludge treatment techniques

67 Sludge treatment techniques are generally employed either to reduce the volume of sludges produced for disposal, or to change the nature of the sludge to a form suitable for re-use (e.g. land application) or for landfill. It should be noted that the final disposal route for sludges liberated from an effluent treatment plant will dictate the level of treatment required; hence the disposal options for sludges should be investigated during the early stages of design.

Sludge thickening

68 Sludge thickening can be applicable to both secondary biological waste sludge and primary solids. Before assessing effective processes for sludge thickening, it must be appreciated that there is a fundamental difference between primary and secondary solids. Primary solids consist mainly of inorganic material and/or primary organic solids. They are able to settle and compact generally without chemical supplementation and as such associated water is not excessively “entrained” within the sludge. The opposite is the case for secondary biological sludges, whereby the water is bound within the flocs and hence is generally more difficult to dewater. Some form of chemical addition will always be required to optimise the dewatering of biological sludges.

69 In order to optimise any dewatering process, where possible ensure that any primary sludges are mixed with biological sludges to help minimise the proportion of entrained water. The exact ratio will depend on the individual site-specific processes and the relative volumes of sludges for disposal.

Indicative BAT requirements for effluent treatment: (Sheet 9 of 10)

70 Sludges that are taken from the bottom of primary and secondary settlement tanks will generally be around 0.5–1.0% dry solids content, with slightly higher values (up to 4% dry solids) for dissolved air flotation. The most straightforward dewatering technique is to allow the sludges to consolidate further in sludge settlement tanks. A number of key design points should be considered when opting for this technique:

- The efficiency of the dewatering process is affected by the height of the sludge layer, and not by the volume of supernatant above it. Therefore the tank should have a specific aspect ratio favouring a tall and narrow profile rather than a low tank with a large surface area.
- Depending upon the details of the primary solids/surplus activated sludge (SAS) removal pattern, consideration should be given to two tanks to allow for quiescent settling of one tank whilst the second is in fill cycle. If this is not possible, arrange the sludge inlet to be near the top of the tank, possibly onto a baffle plate, to minimise hydraulic disturbance.
- Allow for gentle agitation within the tank (a picket fence thickener within the tank is most commonly used) to help reduce stratification of the sludge and to assist in the release of any entrained gases and water.
- Residence time within the tank will be entirely dependent upon the nature of the sludges and excessive retention must be avoided to minimise the possibility of anaerobic conditions occurring with consequent odour and corrosion problems.
- Addition rates to the thickener should be in the range of 20–30 m^3 of feed/m^2 of surface area/day.

71 A conventional gravity/picket fence thickener should be capable of thickening the sludge up to 4–8% dry solids, again dependent on the nature of the raw sludge and in particular the relative content of primary sludge.

72 For many sites, sludge thickening is sufficient alone to reduce the volume of sludge to a level that enables off-site disposal to be undertaken in a sufficiently cost-effective manner. For larger sites, the thickening process is a first stage prior to further dewatering.

Sludge dewatering

73 Sludge dewatering increases the dry solids content of a sludge, producing a “solid” waste. It is a grey area as to where a liquid sludge becomes a solid waste; however, any sludge over 10% dry solids becomes difficult and expensive to pump. Dewatering produces a sludge “cake”, which may be between 20 and 50% dry solids, which will in turn significantly reduce disposal costs.

74 In most cases, further dewatering will first require some form of chemical conditioning to assist in the separation of the bound and entrained water from within the sludge. There is a wide range of high-molecular-weight polymeric flocculants that are particularly effective and the high price of such chemicals should be more than offset by the improvement in performance of the dewatering process. The chemical suppliers should also carry out a regular testing regime (often based on the WRc Capillary Suction Timer apparatus) to optimise dosage. It is strongly recommended that Operators should also become familiar with this apparatus to regularly monitor plant performance against chemical usage.

75 A number of sludge dewatering processes exist and selection will depend upon the nature and frequency of solids produced, and the sludge cake required:

- Filter (or plate) presses are batch processes, and can be manually intensive. The “plates” are covered with a suitable filter cloth (dependent upon the application) and the sludge is fed into the plate cavity. The sludge is dewatered under pressure with the filtrate passing through the filter cloth. Once the pressure is released and the plates separated, the cake is either manually scraped off or vibration mechanisms employed to automate the process. A filter press can produce up to 40% dry solids cake.

Indicative BAT requirements for effluent treatment: (Sheet 10 of 10)

- The belt press is a continuous process with the filter cloth continually running through rollers that forcefully dewater the sludge. Performance optimisation requires regular and specialised maintenance. A belt press can produce up to 35% dry solids cake. Chemical costs are generally quite high.
- Centrifuges are also continuous processes that should produce a cake of up to 40% dry solids for certain sludges. Because of the “closed” nature of the centrifuge, associated odour problems are minimal.
- The screw press is particularly suited to waste which has a high proportion of primary screenings; the screw press should produce cake of 25–30% dry solids.

76 For existing activities, the Operator should implement any agreed techniques to a timescale agreed with the Regulator.

Table 2.9: Water treatment for the Food and Drink sector

Classification	Objective	Techniques
Opportunities to reduce wastewater loading	To keep raw materials and product out of the wastewater stream (see **Releases to water references**)	Dry cleaning
		Installation and maintenance of drain catchpots
	Reduce fluctuations in effluent flow and strength	Flow equalisation
	Prevent damage to treatment plant	Diversion tanks
Primary treatment (“Primary treatment” on page 53) At locations where the wastewater is discharged to sewer, there is usually no treatment beyond the primary stage	Removal of gross solids and gross contaminants such as fats, oils and greases (FOG)	Screening
	Removal of suspended solids	Centrifugation
		Gravity settlement
		Air flotation
Secondary treatment (“Secondary treatment” on page 56)	Removal of BOD	Aerobic treatment
		Anaerobic treatment
	Sludge treatment and disposal	Thickening and dewatering
Tertiary treatment (“Tertiary treatment” on page 56)	Recycling of water	Macrofiltration
		• Membranes

Table 2.10: Summary of aerobic and anaerobic treatment processes

Aerobic	There are a number of aerobic reactor configurations:
Conventional activated sludge	This is a suspended growth process followed by secondary settlement tanks in order to separate the activated sludge from the final effluent. A portion of the settled sludge is returned to the reactor as RAS (returned activated sludge). The remainder is classed as SAS (surplus activated sludge). The rate of SAS wastage in turn dictates the second important design parameter, the sludge age. The SAS will require disposal and possibly on-site treatment (see "Sludge treatment and disposal" on page 58).
Pure oxygen systems	Pure oxygen systems, although expensive, do have a number of operational advantages over conventional aeration systems, including: • the ability to intensify the process by operating at higher (MLSS) levels and hence occupying a smaller footprint • operating at extremely long sludge ages and encouraging endogenous respiration (whereby the various components of the biomass ingest each other) and hence significantly reducing sludge disposal costs • reducing odour potential as the surface of the aeration tank is essentially unbroken – in conventional aeration plants, 70% of the energy is "wasted" due to the nitrogen occupying 70% of the air by volume
Membrane bioreactors (MBRs)	A variation on conventional activated sludge systems whereby a number of membrane modules, or "cartridges", are placed either within the body of the reactor vessel or external to it. Clarified effluent passes through the membranes, under static head pressure, to separate the treated effluent from the MLSS. Two distinct advantages are that no secondary clarifiers are required and also very high MLSS can be achieved (typically 12,000–25,000 mg/l), resulting in more compact plant sizes and accelerated removal rates. See **Figure 2.3** and **Table 2.11** on page 62.
Sequencing batch reactor (SBRs)	SBRs are essentially "fill and draw" processes that give rise to conventional activated sludge. A typical SBR has five cycles, all occurring within a single reactor vessel (there is no need for a secondary clarifier): (1) Fill, (2) React, (3) Settle, (4) Decant, (5) Idle. The process is very flexible, but a greater degree of operator involvement in managing a number of process changes which are possible within the operating cycles (e.g. enhanced denitrification during the idle phase) can be offset by use of automated systems.
Biofilters	In common with the activated sludge system, it is imperative that there is a constant supply of food (BOD) and oxygen to the biomass, as well as an efficient route for transport of dead cells and other inert material away from the active site. In order that sloughing can effectively take place without blocking the media, it is important that the hydraulics and voidage within the media are correct.
Biological aerated flooded filters (BAFF) Submerged biological aerated filters (SBAF)	These are hybrid suspended/attached growth systems which are best described as an activated sludge plant which contains high voidage media to encourage bacterial growth. They also generally allow a certain amount of physical filtration within the same structure. Influent is limited to <1500 mg/l BOD. Backwashing takes place approximately every 24 hours to remove surplus biomass, and as such secondary clarification is not required.
Anaerobic	There are three main types of basic anaerobic reactor configurations
Anaerobic contact processes	The anaerobic contact process can be likened to the aerobic activated sludge process; separation and recirculation of the biomass are incorporated into the design.

Table 2.10: Summary of aerobic and anaerobic treatment processes

Anaerobic filter	In the anaerobic filter the growth of anaerobic bacteria is established on a packing material. The packing retains the biomass within the reactor, and it also assists in the separation of the gas from the liquid phase. The system can be operated in the upflow or downflow mode.
Upflow anaerobic sludge blanket (UASB)	The wastewater is directed to the bottom of the reactor for uniform distribution. The wastewater passes through a blanket of naturally formed bacterial granules. The bacteria carry out the reactions and natural convection lifts a mixture of gas, treated effluent and sludge granules to the top of the reactor. Patented three-phase separator arrangements are used to separate the final effluent from the solids (biomass) and the biogas. Loadings of up to 60 kg/m^3/day have been reported, but more typical data would be a loading rate of 10 kg/m3/day with an (HRT) of 4 h. UASB is not suitable for effluent containing high solids or FOG.
	Some recent advances in anaerobic treatment technology have seen a number of variations of the process developed:
The reactor (internal circulation)	One of the main advantages is that the IC reactor can undergo a certain amount of “self-regulation” irrespective of the variations in incoming flows and loads. As the load increases, the quantity of methane generated also increases, so further increasing the degree of recirculation and hence dilution of the incoming load. Typical loading rates for this process are in the range of 15–35 kgCOD/m^3/day.
Expanded granular sludge blanket (EGSB)	Similar to the aerobic filters reviewed previously, the EGSB process incorporates an amount of support media – often no more than sand or synthetic plastic materials. Light materials are often used in order to minimise the upflow velocities required to fluidise the beds, with particle sizes typically 0.3–1.0 mm. Typical loading rates for this process are in the range of 15–35 kgCOD/m^3/day.
The hybrid process	A further variation on the conventional UASB, incorporating a packed media zone above the main open zone. This allows for the collection and retainment of non-granulated bacteria that, in conventional UASB reactors, would be lost from the process.

Table 2.11: Membrane bio reator (MBR) - activated sludge (AS) comparison

	MBR	AS
Tank volume required for the process biology	2000 m^3	10,300 m^3
Land surface area occupied by the biology tank volume	254 m^2	1, 800 - 2,600 m^2
Land surface area required for the final effluent/sludge separation	Membrane area 24 m^2	2 x settlement tanks 474 m^2
BOD in the effluent discharged to river	<10 mg/l	<20 mg/l can be achieved
Suspend solids discharge	<1 mg/l	<30 mg/l can be achieved

2.2.3 Abatement of point source emissions to groundwater

Groundwater protection legislation

The Groundwater Regulations for the UK came into force on 1 April 1999, and an IPPC Permit will be subject to the following requirements under these Regulations.

i. The Permit shall not be granted at all if it would allow the *direct discharge* of a List I substance (Regulation 4(1)) - except in very limited circumstances (see Notes 1 and 2, below).

ii. If the Permit allows the disposal of a List I substance or any activity that might lead to an *indirect discharge* of a List I substance then *prior investigation* (as defined in Regulation 7) is required and the Permit shall not be granted if this reveals that indirect discharges of List I substances would occur. In any event, conditions to secure the prevention of such discharges must be imposed (Regulation 4(2) and (3)).

iii. In the case of List II substances, Permits allowing direct discharges or possible indirect discharges, cannot be granted unless there has been a prior investigation and conditions must be imposed to prevent groundwater pollution (Regulation 5).

iv. The Regulations contain further detailed provisions covering *surveillance* of groundwater (Regulation 8); conditions required when direct discharges are permitted (Regulation 9); when indirect discharges are permitted (Regulation 10); and review periods and compliance (Regulation 11).

The principles, powers and responsibilities for groundwater protection in England and Wales, together with the Environment Agency's policies on this, are outlined in the Environment Agency's document **Policy and Practice for the Protection of Groundwater**. This outlines the concepts of vulnerability and risk and the likely acceptability from the Regulator's viewpoint of certain activities within groundwater protection zones. These are categorised as:

A Prior investigation of the potential effect on groundwater of on-site disposal activities or discharges to groundwater. Such investigations will vary from case to case, but the Regulator is likely to require a map of the proposed disposal area; a description of the underlying geology, hydrogeology and soil type, including the depth of saturated zone and quality of groundwater; the proximity of the site to any surface waters and abstraction points, and the relationship between ground and surface waters; and the composition and volume of waste to be disposed of; and the rate of planned disposal.

The Environment Agency has produced a series of maps for England and Wales, which provide a guide to potential groundwater vunerability. Source Protection Zones are intended to aid protection by defining annular zones around each major potable source, including springs, boreholes and wells, based on travel times.

B Surveillance - This will also vary from case to case, but will include monitoring of groundwater quality and ensuring the necessary precautions to prevent groundwater pollution are being undertaken.

Note 1 The Regulations state that, subject to certain conditions, the discharges of List I substances to groundwater may be authorised if the groundwater is "permanently unsuitable for other uses". Advice must be sought from the Regulator where this is being considered as a justification for such discharges.

Note 2 List I and List II refer to the list in the Groundwater Regulations and should not be confused with the similar lists in the Dangerous Substances Directive (see **Appendix 3**)

Indicative BAT requirements for point source emissions to groundwater Identify if there may be a discharge of any List I or List II substances and if any are identified, explain how the requirements of the Groundwater Regulations 1998 have been addressed.	
1	In general, there should be no permitted releases to groundwater of either a direct or indirect nature.
2	If there are releases to groundwater and they are to continue, the requirements of the Regulations, as summarised above, must be complied with.

2.2.4 Control of fugitive emissions to air

Common sources of fugitive emissions are:

- open vessels (e.g. the effluent treatment plant)
- the loading and unloading of transport containers
- transferring material from one vessel to another (e.g. silos)
- conveyor systems
- pipework and ductwork systems (e.g. pumps, valves, flanges, catchpots, drains, inspection hatches etc.)
- poor building containment and extraction
- potential for by-pass of abatement equipment (to air or water)
- accidental loss of containment from failed plant and equipment

As part of the Application the Operator should identify and, where possible quantify, significant fugitive emissions to air from all the specific relevant sources listed above, estimating the proportion of total emissions that are attributable to fugitive releases for each substance. Where there are opportunities for reductions, the Permit may require the updated inventory of fugitive emissions to be submitted.

Indicative BAT requirements for fugitive emissions to air: (Sheet 1 of 2)	
1	**Dust** - The following general techniques should be employed where appropriate: • Covering of skips and vessels • Avoidance of outdoor or uncovered stockpiles (where possible) • Where dust creation is unavoidable, use of sprays, binders, stockpile management techniques, windbreaks and so on • Regular wheel and road cleaning (avoiding transfer of pollution to water and wind blow) • Closed conveyors, pneumatic or screw conveying (noting the higher energy needs), minimising drops. Filters on the conveyors to clean the transport air prior to release • Regular housekeeping • Enclosed silos (for storage of bulk powder materials) vented to fabric filters. The recycling of collected material should be considered under Section 2.6. • Enclosed containers or sealed bags used for smaller quantities of fine materials

Indicative BAT requirements for fugitive emissions to air: (Sheet 2 of 2)	
2	**VOCs** • When transferring volatile liquids, the following techniques should be employed – subsurface filling via (anti-syphon) filling pipes extended to the bottom of the container, the use of vapour balance lines that transfer the vapour from the container being filled to the one being emptied, or an enclosed system with extraction to suitable abatement plant. • Vent systems should be chosen to minimise breathing emissions (for example pressure/ vacuum valves) and, where relevant, should be fitted with knock-out pots and appropriate abatement equipment. • Maintenance of bulk storage temperatures as low as practicable, taking into account changes due to solar heating etc. • The following techniques should be used (together or in any combination) to reduce losses from storage tanks at atmospheric pressure: – Tank paint with low solar absorbency – Temperature control – Tank insulation – Inventory management – Floating roof tanks – Bladder roof tanks – Pressure/vacuum valves, where tanks are designed to withstand pressure fluctuations – Specific release treatment (such as adsorption condensation)
3	For Information on Odour, see **Section 2.2.6** on page 67.

2.2.4.1 Chilling and freezing equipment

- Losses of refrigerants from pipe joints, shaft seals and gaskets.
- Deliberate venting of refrigerants to the air.

Indicative BAT requirements for fugitive emissions to air in relation to chilling and freezing equipment:	
1	The Operator should describe the measures and procedures in place and proposed to prevent or reduce fugitive emissions to air. This should include, but is not limited to, the general measures described below. The Operator should justify where any of the measures are not employed. • Regular inspection should be carried out using proprietary leak detection equipment; • Ensure that a system log book is kept which records: • quantity of refrigerant and oil added to or removed from the system(s) • leakage testing results • location and details of specific incidents • Monitor plant performance.
2	Under no circumstances should refrigerants be vented to the atmosphere.
3	For existing activities, the above standards should be met within the timescale given in **Section 1.4.2** on page 6.

2.2.5 Control of fugitive emissions to surface water, sewer and groundwater

As part of the Application, the Operator should identify and, where possible, quantify significant fugitive emissions to water, sewer or ground from all relevant sources, and estimate the proportion of total emissions that are attributable to fugitive releases for each of the main substances releases.

Some common examples of sources of fugitive releases to waters and their preventive measures are given in the BAT box below.

Indicative BAT requirements for fugitive emissions to water: (Sheet 1 of 2)

1 The Operator should describe the measures and procedures in place and proposed to prevent or reduce fugitive emissions to water and land. This should include, but is not limited to, the measures described below. The Operator should justify where any of the measures are not employed.

General techniques

2 For **subsurface structures**:
- establish and record the routing of all installation drains and subsurface pipework;
- identify all sub-surface sumps and storage vessels;
- engineer systems to minimise leakages from pipes and ensure swift detection if they do occur, particularly where hazardous (ie. Groundwater-listed) substances are involved;
- provide secondary containment and/or leakage detection for sub-surface pipework, sumps and storage vessels;
- establish an inspection and maintenance programme for all subsurface structures, eg. pressure tests, leak tests, material thickness checks or CCTV

3 All sumps should:
- be impermeable and resistant to stored materials;
- be subject to regular visual inspection and any contents pumped out or otherwise removed after checking for contamination;
- where not frequently inspected, be fitted with a high level probe and alarm, as appropriate;
- be subject to programmed engineering inspection (normally visual, but extending to water testing where structural integrity is in doubt).

4 For **surfacing**:
- design appropriate surfacing and containment or drainage facilities for all operational areas, taking into consideration collection capacities, surface thicknesses, strength/reinforcement; falls, materials of construction, permeability, resistance to chemical attack, and inspection and maintenance procedures;
- have an inspection and maintenance programme for impervious surfaces and containment facilities;
- unless the risk is negligible, have improvement plans in place where operational areas have not been equipped with:
  - – an impervious surface
  - – spill containment kerbs
  - – sealed construction joints
  - – connection to a sealed drainage system

Indicative BAT requirements for fugitive emissions to water: (Sheet 2 of 2)	
5	All **above-ground tanks** containing liquids whose spillage could be harmful to the environment should be bunded. For further information on bund sizing and design, see the **Releases to water references**. Bunds should: • be impermeable and resistant to the stored materials; • have no outlet (that is, no drains or taps) and drain to a blind collection point; • have pipework routed within bunded areas with no penetration of contained surfaces; • be designed to catch leaks from tanks or fittings; • have a capacity greater than 110 percent of the largest tank or 25 percent of the total tankage, whichever is the larger; • be subject to regular visual inspection and any contents pumped out or otherwise removed under manual control after checking for contamination; • where not frequently inspected, be fitted with a high-level probe and an alarm, as appropriate; • where possible, have tanker conection points within the bund, otherwise provide adequate containment; • be subject to programmed engineering inspection (normally visual, but extending to water testing where structural integrity is in doubt).
6	**Storage areas for IBCs, drums, bags, etc,** should be designed and operated to minimise the risk of releases to the environment. In particular: • Storage areas should be located away from watercourses and sensitive boundaries, (eg. those with public access) and should be protected against vandalism. • Storage areas should have appropriate signs and notices and be clearly marked-out, and all containers and packages should be clearly labelled. • The maximum storage capacity of storage areas should be stated and not exceeded, and the maximum storage period for containers should be specified and adhered to. • Appropriate storage facilities should be provided for substances with special requirements (eg. flammable, sensitive to heat or light) and formal arrangements should be in hand to keep separate packages containing incompatible substances (both “pure” and waste). • Containers should be stored with lids, caps and valves secured and in place - and this also applies to emptied containers. • All stocks of containers, drums and small packages should be regularly inspected (at least weekly). • Procedures should be in place to deal with damaged or leaking containers.
7	Designated cleaning areas • Designated and clearly marked cleaning areas should be provided for mobile equipment, for example trolleys, and these areas must not discharge into surface water drains. • The cleaning of yard and parking areas using steam or pressure cleaners should not be carried out unless the effluent generated can be contained by isolating the area from the surface water drainage system.

2.2.6 Odour

The level of detail supplied should be in keeping with the risk of causing odour-related annoyance at sensitive receptors.

Where an installation poses no risk of odour-related environmental impact because the activities undertaken are inherently non-odorous, this should be justified and no further information relating to odour need normally be supplied.

Where odour could be a problem, the Operator will be required in the Application to supply the information as indicated below:

- Information relating to sensitive receptors, in particular the type of receptor, location relative to the odour sources and an assessment of the impact of odorous emissions on the receptors. Where detailed information is required the Operator may be able to secure an agreement to supply this as part of an Improvement Programme.
- An overview of any complaints received, what they relate to (source/operation) and remedial action taken.
- The types and source of odorous substances used or generated, intentional and fugitive (unintentional) release points and monitoring undertaken.
- Actions taken to prevent or minimise
  – A description of the actions taken to prevent and/or minimise odour annoyance for each odour source.
  – A demonstration that the indicative BAT requirements are being complied with.
  – Identification of any circumstances or conditions which might compromise the ability to prevent or minimise odour annoyance, and a description of the actions that will be taken to minimise the impact.

There may be a requirement placed upon the Operator to provide some or all of this information in the form of an odour management statement.

Indicative BAT requirements for odour control: (Sheet 1 of 2)

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

2 Where odour can be contained, for example within buildings, the Operator should maintain the containment and manage the operations to prevent its release at all times.

3 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 the Operator 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 the view of the Regulator, to increase the odour impact at receptors, the Operator should take appropriate and timely action, as agreed with the Regulator, to prevent further annoyance (these agreed actions will be defined either in the Permit or in an odour management statement).

4 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.

Indicative BAT requirements for odour control: (Sheet 2 of 2)

5 Where an installation releases odours but has a low environmental impact by virtue of its remoteness from sensitive receptors, it is expected that the Operator will work towards achieving the standards described in this Note, but the timescales allowed to achieve this might be adjusted according to the perceived risk.

Fugitive emissions

6 Conventional heating methods for cooking and sterilisation, involving the application of tangible heat to the product, can lead to the release of odours. There is a range of alternative unit processes, which can achieve the same objectives while potentially minimising the release of objectionable odour. These include:

- Ohmic heating. Consists of running a current through the food to achieve the heating. It has been used to replace the traditional can heating processes and has wide application in the ready meals sector. There are additional advantages regarding cleaning (as that no fouling means that after one product has been processed, the plant is washed through with a base sauce and the next product introduced) and energy efficiency (energy conversion >90%).
- Application of high pressure. Can be used to denature proteins thus affecting the activity of enzymes and reducing odour production. Usually the process requires flexible packaging that can stand the high pressures of between 50,000 and 100,000 psi. This process has found application in jams, yoghurts and pourable salad dressings.
- Radiofrequency melting and softening. For applications in sugar confectionery, chocolate, cooking and shortening of fats. It offers the advantage of a uniform product temperature and eliminates excessive surface temperatures that can damage the product.

2.3 Management techniques

Within IPPC, an effective system of management is a key technique for ensuring that all appropriate pollution prevention and control techniques are delivered reliably and on an integrated basis.

The Regulators strongly support the operation of formal environmental management systems (EMSs). An Operator with such a system will not only find it easier to meet the BAT requirements for management of the installation but also many of the technical/regulatory requirements listed in other Sections of this Guidance.

The Regulators recommend either certification to the ISO 14001 standard or registration under EMAS (EC Eco Management and Audit Scheme) (OJ L114, 24/04/01). Both certification and registration provide independent verification that the EMS conforms to an auditable standard. EMAS now incorporates ISO 14001 as the specification for the EMS element, and the Regulators consider that overall EMAS has a number of other benefits over ISO14001 - including a greater focus on environmental performance, a greater emphasis on legal compliance, and a public environmental statement. For further details about ISO 14001 and EMAS contact British Standards Institute (BSI) or the Institute of Environmental Management and Assessment (IEMA), respectively.

Whilst an effective EMS will help the Operator to maintain compliance with specific regulatory requirements and manage all significant environmental impacts, this section of the Guidance identifies only those EMS requirements that are not specifically covered elsewhere in the document. This Section should not, therefore, be taken to describe all of the elements of an effective environmental management system. The requirements below are considered to be BAT for IPPC, but they are the same techniques required by a formal EMS and so should be capable of delivering wide environmental benefits.

BREF Sections 4.4.1, 5.4.2, 6.4.2

Indicative BAT requirements for management techniques (Sheet 1 of 3)

Operations and maintenance

1 Effective operational and maintenance systems should be employed on all aspects of the process whose failure could impact on the environment, in particular there should be:
- documented procedures to control operations that may have an adverse impact on the environment
- a defined procedure for identifying, reviewing and prioritising items of plant for which a preventative maintenance regime is appropriate
- documented procedures for monitoring emissions or impacts
- a preventative maintenance programme covering all plant, whose failure could lead to impact on the environment, including regular inspection of major ‘non productive’ items such as tanks, pipework, retaining walls, bunds ducts and filters

2 The maintenance system should include auditing of performance against requirements arising from the above and reporting the result of audits to top management.

Competence and training

3 Training systems, covering the following items, should be in place for all relevant staff which cover
- awareness of the regulatory implications of the Permit for the activity and their work activities
- awareness of all potential environmental effects from operation under normal and abnormal circumstances
- awareness of the need to report deviation from the Permit
- prevention of accidental emissions and action to be taken when accidental emissions occur

Indicative BAT requirements for management techniques (Sheet 2 of 3)

4 The skills and competencies necessary for key posts should be documented and records of training needs and training received for these post maintained.

5 The key posts should include contractors and those purchasing equipment and materials.

6 The potential environmental risks posed by the work of contractors should be assessed and instructions provided to contractors about protecting the environment while working on site.

7 Where industry standards or codes of practice for training exist (e.g. WAMITAB) they should be complied with.

Accidents/incidents/non-conformance

8 There should be an accident plan as described in **Section 2.8** on page 90 which:
- identifies the likelihood and consequence of accidents
- identifies actions to prevent accidents and mitigate any consequences

9 There should be written procedures for handling, investigating, communicating and reporting actual or potential non-compliance with operating procedures or emission limits.

10 There should be written procedures for handling, investigating, communicating and reporting environmental complaints and implementation of appropriate actions.

11 There should be written procedures for investigating incidents, (and near misses) including identifying suitable corrective action and following up

Organisation

12 The following are indicators of good performance which may impact on the Regulator's resources, but not all will necessarily be insisted upon as Permit conditions:

13 The company should adopt an environmental policy and programme which:
- includes a commitment to continual improvement and prevention of pollution;
- includes a commitment to comply with relevant legislation and other requirements to which the organisation subscribes; and
- identifies, sets, monitors and reviews environmental objectives and key performance indicators independently of the Permit.

14 The company should have demonstrable procedures (eg. written instructions) which incorporate environmental considerations into the following areas:
- the control of process and engineering change on the installation;
- design, construction and review of new facilities and other capital projects (including provision for their decommissioning);
- capital approval; and
- purchasing policy.

15 The company should conduct audits, at least annually, to check that all activities are being carried out in conformity with the above requirements. Preferably, these should be independent.

16 The company should report annually on environmental performance, objectives and targets, and future planned improvements. Preferably, these should be published environmental statements.

Indicative BAT requirements for management techniques (Sheet 3 of 3)

17 The company should operate a formal Environmental Management System. Preferably, this should be a registered or certified EMAS/ISO 14001 system (issued and audited by an accredited certification body).

18 The company should have a clear and logical system for keeping records of, amongst others:
- policies
- roles and responsibilities
- targets
- procedures
- results of audits
- results of reviews

2.4 Raw materials

This section covers the use of raw materials and water, and the techniques for both minimising their use and minimising their impact by selection. (Energy and fuels are covered under Section 2.7 on page 86, Energy).

As a general principle, the Operator will need to demonstrate the measures taken to:

- reduce the usage of all raw materials and intermediates (Section 2.4.2 on page 75)
- 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 (Section 2.4.2 on page 75)

2.4.1 Raw materials selection

Summary of materials in use

A proportion of virtually all of the raw materials and auxiliary chemicals (for example, cleaning materials) used will end up as a waste or in the final effluent, even if much reduced by treatment.

Although the selection of the primary raw material (the foodstuff ingredients) is fixed by the requirements of the product, some significant pollution impacts are associated with the primary raw materials. These can range from materials such as soil attached to root crops, to pesticides and herbicides connected with the source crop. Other than foodstuffs and energy, water is the main raw material, and this is dealt with in Section 2.4.3 on page 78. The other important class of raw materials are the auxiliary chemicals (see Table 2.12 below).

Table 2.12: Auxiliary materials

Raw material	Purpose	Summary of potential environmental impacts
Organic solvents	Extraction of food components	Solvents used include methylene chloride, acetone, ethyl ether, hexane, heptane and cyclohexane. They exhibit a range of toxicity, flammability and volatility, and present an accident risk and a source of VOC emissions
Salt, sodium nitrite and nitrate	Brining and curing agents	Wash down into effluent will affect effluent quality. Chloride (brine) is a conservative substance and is, therefore, not reduced through effluent treatment, apart from dilution
Caustic	Fruit and vegetable peeling	Produces a high pH wastewater
Citric acid	Blanching aid	Produces a low pH wastewater
Ferrous sulphate	Water treatment chemicals	Spillage or incorrect use will create an acidic solution
Chlorinated water	Washing	
Ammonia	Refrigerant	Very potent pollutant in event of spillage into watercourse or sewer. Leaks from refrigeration system will result in emissions to air
Ethylene glycol and water	Refrigerant	Has a high oxygen demand in event of spillage into watercourse or sewer

Table 2.12: Auxiliary materials

R404 and R22 (an HCFC)	Refrigerant	Leaks from refrigeration system will result in emissions to air and these refrigerants are contributors to ozone depletion
Packaging		Excess will require recycling or disposal (see **Section 2.4.2.2** on page 77)
Caustic acids (e.g. nitric, phosphoric acids), bleaches, biocides	Cleaning and sanitisation materials	Even in the diluted form used for cleaning purposes a proportion of the chemicals will end up in the final effluent, even if much reduced by treatment. Potent pollutants in the event of spillage into a watercourse or sewer

This section looks at the selection and substitution of raw materials and **Section 2.4.2** on page 75 describes the techniques to minimise their use.

It should be recognised that the process of selecting raw materials can present an opportunity to control emissions at source. In this regard it is suggested that Operators closely examine the range of possible raw material options available to them.

The Operator should supply in the Application a list of the materials used which have potential for significant environmental impact, together with the following associated information:

- the chemical composition of the materials, where relevant;
- the quantities used;
- the fate of the material in the installation (ie. approximate percentages to each environmental medium and to the products);
- the environmental impact potential, where known (eg. degradability, bioaccumulation potential, toxicity to relevant species);
- any reasonably practicable alternative raw materials that may have a lower environmental impact (including, but not limited to any alternatives described in the BAT requirements below) on the substitution principle;
- and justification for the continued use of any substance for which there is a less hazardous alternative (eg. on the basis of impact on product quality) to show that the proposed raw materials are therefore BAT.

Indicative BAT requirements for raw materials selection:	
1	The Operator should maintain a list of raw materials and their properties as noted above.
2	The Operator should have procedures for the regular review of new developments in raw materials and for the implementation of any suitable ones with an improved environmental profile.
3	The Operator should have quality-assurance procedures for controlling the impurity content of raw materials.
4	The Operator should complete any longer-term studies needed into the less polluting options and should make any material substitutions identified.

Table 2.13: Raw material substitutions

Raw material	Selection techniques
Organic solvents	Supercritical Fluids: The use of supercritical carbon dioxide, for example, in the caffeine extraction process has eliminated the use of the more conventional hexane solvent
Cleaning and sanitisation materials (see **Section 2.1.11** on page 40)	Chemical agents with rapid degradation and known degradation products should be used. Assess the types and ranges of cleaning agents; for example, are acid washes required?
Caustic for fruit and vegetable peeling (see **Section 2.1.3.4** on page 20 and **Section 2.2.2.1** on page 49)	Only "low-mercury" NaOH should be used.
Fuels	See **Section 2.7.3** on page 89.

2.4.2 Waste minimisation

Principles

The options for waste recovery and recycling are covered in **Section 2.6** on page 84. Waste avoidance/minimisation, and the use of clean technologies, is a theme which runs throughout **Section 2.1** on page 15 and **Section 2.2** on page 44. This section deals with the systematic approach to look for other opportunities.

Waste minimisation can be defined simply as: *"a systematic approach to the reduction of waste at source, by understanding and changing processes and activities to prevent and reduce waste".*

A variety of techniques can be classified under the term waste minimisation, from basic housekeeping through statistical measurement, to application of clean technologies.

In the context of waste minimisation and this Guidance, waste relates to the inefficient use of raw materials and other substances at an installation. A consequence of waste minimisation will be the reduction of gaseous, liquid and solid emissions.

Key operational features of waste minimisation will be:

- the ongoing identification and implementation of waste prevention opportunities
- the active participation and commitment of staff at all levels including, for example staff suggestion schemes
- monitoring of materials' usage and reporting against key performance measures

For the primary inputs to activities which are themselves waste activities, eg. incineration, the requirements of this section may have been met "upstream" of the installation. However, there may still be arisings that are relevant.

See the **Waste minimisation support references** for detailed information, guides and case studies on waste minimisation techniques.

Indicative BAT requirements for waste minimisation audits **Identify the raw and auxiliary materials, other substances and water that they propose to use.**
1 The Operator should carry out a waste minimisation audit at least every 4 years. If an audit has not been carried out in the 2 years prior to submission of the application and the details made known at the time of the application, then the first audit shall take place within 2 years of the issue of the Permit. The methodology used and an action plan for reducing the use of raw materials should be submitted to the Regulator within 2 months of completion of the audit. The audit should be carried out as follows:
2 The Operator should analyse the use of raw materials, assess the opportunities for reductions and provide an action plan for improvements using the following three essential steps • process mapping • materials mass balance • action plan
3 The use and fate of raw materials and other materials, including by-products, solvents and other support materials, such as fuels, catalysts and abatement agents, should be mapped onto a process flow diagram (see the **Waste minimisation support references**). This should be achieved by using data from the raw materials inventory and other company data as appropriate. Data should be incorporated for each principal stage of the operation in order to construct a mass balance for the installation.
4 Using this information, opportunities for improved efficiency, changes in process and waste reduction should be generated and assessed. An action plan should then be prepared for implementing improvements to a timescale approved by the Regulator.

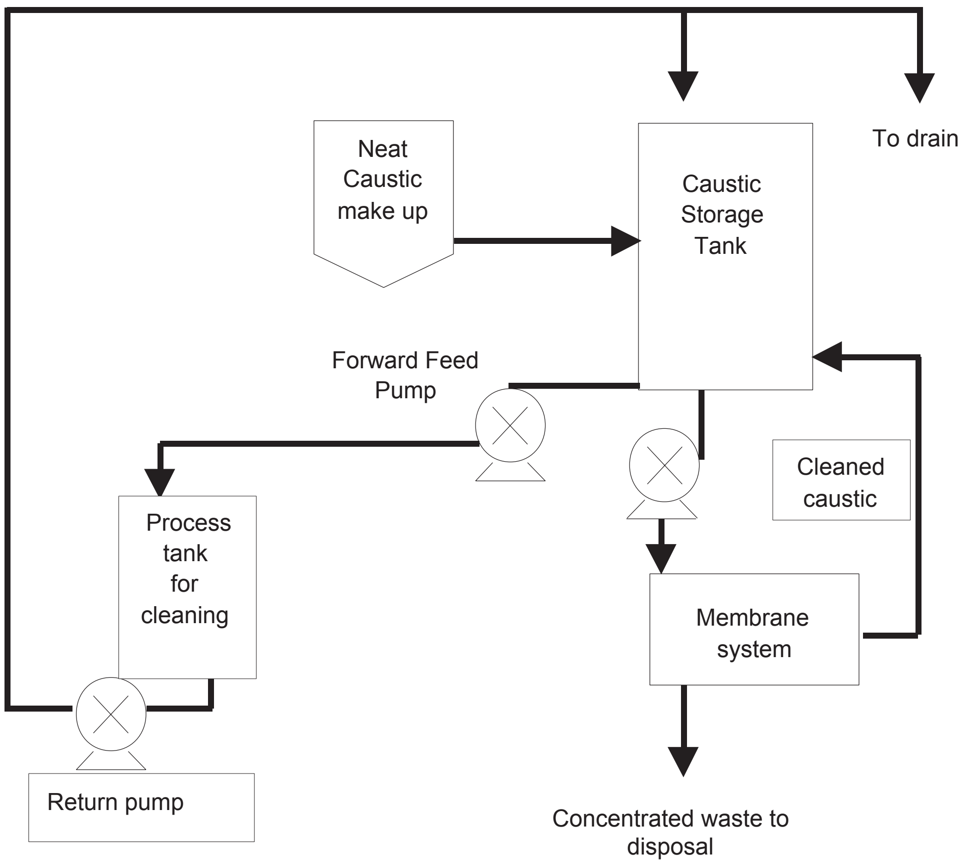
2.4.2.1 Recycling of auxiliary chemicals

It was stated in **Section 2.4.1** on page 73 that a proportion of the chemicals used for cleaning purposes will end up in the final effluent, even if much reduced by treatment. This is not only a loss of a raw material, but means that more effort will be required to treat the effluent.

In addition to measures to ensure the optimal application of cleaning chemicals, techniques are becoming available to recover chemicals from, for example, cleaning-in-place (CIP) systems. Nanofiltration can be used to recover 90% of caustic or acid from spent process solutions (Ref. 5), although not all effluent types are compatible with nanofiltration techniques. This may be suitable for large-scale cleaning processes, for example:

- cleaning of evaporators in the dairy sector
- bottle washing in breweries
- general CIP applications

Figure 2.4: Cleaning-in-place chemical recovery membrane system



2.4.2.2 Packaging

Packaging includes a number of raw materials, such as corrugated cartons, plastic bags, shrink-wrap, stretch-wrap, layer pads, pallets and slip sheets, drums and other containers and filler materials (polystyrene, foam, paper), etc. IPPC addresses packaging waste associated with the production process. (The requirement to minimise the impact of packaging and packaging waste on the environment in general is regulated under the Producer Responsibility Obligations (Packaging Waste) Regulations 1997 (as amended) and the Packaging Essential Requirements Regulations 1998 (regulated by local authority Trading Standards Officers).)

Pollution prevention with respect to waste packaging should be addressed using the waste minimisation hierarchy, hence:

- avoiding packaging
- reducing packaging
- re-using packaging
- recycling packaging

The optimum packaging size should be used, which takes account of product size, shape, weight, distribution requirements and packaging material selected (without compromising product protection, preservation and containment). The packaging must achieve fitness of purpose, minimise the amount of packaging material used, maximise the amount of product per pallet and optimise warehouse storage. Often by designing the packaging effectively, waste can be avoided or at least reduced.

A large variety of packaging materials exist within the Food and Drink sector. Packaging materials should be selected that cause the least environmental impact. To keep waste to a minimum, the weight and volume of each material, together with its recycled content, should be considered, as should the potential for re-use, recycling and disposal of the packaging. Often one material can replace the need for another; for example, recyclable shrink-wrap could replace the need for cardboard trays and shrink-wrap.

2.4.3 Water use

The Food and Drink sector has traditionally been a large user of water as an ingredient, cleaning agent, means of conveyance and feed to utility systems. Large food processing installations will use several hundred cubic metres of water a day, either from mains or borehole supply. Uses include:

- washing of raw materials
- water used for transporting (fluming) raw material or waste
- process water
- cleaning of plant, process lines, equipment and process areas
- washing of product containers
- heating and cooling
- boiler make-up

Reasons for reducing water use

Water use should be minimised within the BAT criteria for the prevention or reduction of emissions and be commensurate with the prudent use of water as a natural resource.

Reducing water use is usually a valid environmental (and economic) aim in itself, but any water passing through an industrial process is degraded by the addition of pollutants so there is generally an increase in pollutant load. The benefits to be gained from reducing water input include:

- reducing the size of (a new) treatment plant, thereby supporting the BAT cost-benefit justification of better treatment;
- cost savings where water is purchased from or disposed of to another party;
- associated benefits within the process such as reduced energy requirements for heating and pumping, and reduced dissolution of pollutants leading in turn to reduced sludge generation in the effluent treatment plant (and consequent disposal costs).

The use of a simple mass balance for water use should help to reveal where reductions can be made.

Advice on cost-effective measures for minimising water can be found in the **Water efficiency references:**.

Indicative BAT requirements for minimisation of water use (Sheet 1 of 4)
Identify the raw and auxiliary materials, other substances and *water* that they propose to use.

1 The Operator should carry out a regular review of water use (water efficiency audit) at least every 4 years. If an audit has not been carried out in the 2 years prior to submission of the application and the details made known at the time of the application, then the first audit should take place within 2 years of the issue of the Permit.

- Flow diagrams and water mass balances for the activities should be produced.
- Water-efficiency objectives should be established, with constraints on reducing water use beyond a certain level being identified (which usually will be usually installation-specific).
- Water pinch techniques should be used in the more complex situations such as chemical plant, to identify the opportunities for maximising reuse and minimising use of water (see the **Water efficiency references:**).

2 Within 2 months of completion of the audit, the methodology used should be submitted to the Regulator, together with proposals for a time-tabled plan for implementing water reduction improvements for approval by the Regulator.

3 The following general principles should be applied in sequence to reduce emissions to water:

- Water-efficient techniques should be used at source where possible
- Water should be recycled within the process from which it issues, by treating it first if necessary. Where this is not practicable, it should be recycled to another part of the process that has a lower water-quality requirement
- In particular, if uncontaminated roof and surface water cannot be used in the process, it should be kept separate from other discharge streams, at least until after the contaminated streams have been treated in an effluent treatment system and been subject to final monitoring.

4 Measures should be in place to minimise the risk of contamination of surface waters or groundwater by fugitive releases of liquids or solids (see **Section 2.2.5** on page 66).

5 The water-quality requirements associated with each use should be established, and the scope for substituting water from recycled sources identified and input into the improvement plan.

6 Less contaminated water streams, such as cooling waters, should be kept separate from more contaminated streams where there is scope for reuse - though possibly after some form of treatment.

7 Most wastewater streams will however need some form of treatment (see **Section 2.2.2** on page 48 for techniques) but for many applications, the best conventional effluent treatment can produces a water that is usable in the process directly or when mixed with fresh water. Though treated effluent quality can vary, it can often be recycled selectively - used when the quality is adequate, discharged when the quality falls below that which the system can tolerate.

8 In particular, the cost of membrane technology continues to reduce, and they can be applied to individual process streams or to the final effluent from the effluent treatment plant, as appropriate. In some applications in some Sectors, they can supplement (or possibly completely replace) the ETP plant so that most water is recyclable and there is a greatly reduced effluent volume. Where the remaining, possibly concentrated, effluent stream is sufficiently small - and particularly where waste heat is available - further treatment by evaporation can lead to zero aqueous effluent. Where appropriate, the Operator should assess the costs and benefits of using membrane techniques to minimise water usage and effluent discharge.

Indicative BAT requirements for minimisation of water use (Sheet 2 of 4)
Identify the raw and auxiliary materials, other substances and *water* that they propose to use.

9 Water usage for cleaning and washing down should be minimised by:
- vacuuming, scraping or mopping in preference to hosing down;
- reusing wash water (or recycled water) where practicable;
- using trigger controls on all hoses, hand lances and washing equipment.

10 Fresh water consumption should be directly measured and recorded regularly at every significant usage point - ideally on a daily basis.

11 The principles for reducing the use of fresh water are:
- monitoring the consumption for each unit process
- implementing measures to reduce use where appropriate, for example flow restrictions for cleaning ring mains
- recycling water within the process from which it issues, by treating it first if necessary. Where that is not practicable, it should be recycled to another part of the process which has a lower water quality requirement. Recycling should take place in as many positions as possible for:
- process feed waters
- conveyance waters
- wash waters

Pumps

12 (Where used) water-sealed vacuum pumps (and product pumps connected to vacuum devices, e.g. a multi-effect evaporator) can account for a considerable water use and arrangements should be reviewed by considering improvements such as:
- cascading seal water through high- to low-pressure pumps
- use of radial fans or centrifugal blowers (100% reduction potential) – however these are not so flexible and would not necessarily be BAT
- by using modern designs with improved internal recirculation of water within the pump casing (up to 50% reduction)

13 PLUS
- filtering and cooling seal water with a heat exchanger prior to re-use in the pumps (90% reduction potential), or
- filtering and cooling seal water with a cooling tower prior to re-use in the pumps (95% reduction potential), or
- filtering and cooling seal water with injected fresh water prior to re-use in the pumps (65% reduction potential),

14 OR
- recycling the hot seal water for cleaning.

15 Any other cooling waters should be separated from contaminated process waters and re-used wherever practicable, possibly after some form of treatment, e.g. re-cooling and screening. Where cooling waters are not re-used, they should not be combined with contaminated waste waters.

16 On rotating shafts, mechanical seals are preferred to seal water systems. They are widely available, the cost is little more and the maintenance is lower. In cases where this is not feasible, flow meters should be fitted to enable the flow to the seal to be monitored and thereby effectively controlled.

Indicative BAT requirements for minimisation of water use (Sheet 3 of 4)
Identify the raw and auxiliary materials, other substances and *water* that they propose to use.

Recycling principles

17 Opportunities for the recycling or re-use of water should be identified and thoroughly evaluated, taking into consideration hygiene issues and practical constraints. An optimal scheme is likely to include a combination of:

- sequential re-use (water stream used for two or more processes or operations before disposal)
- for example, counter-flow re-use, in which the water flows counter-current to the product so that the final product only comes into contact with fresh water (see **Figure 2.5** showing a four-stage counter-flow at a pea cannery)
- recycling within a unit process or group of processes without treatment
- for example, condensate should be returned as boiler feedwater (where it is of suitable quality) and contaminated condensate should be used for lower-grade cleaning activities, e.g. yard washing
- recycling with treatment

Recycling of ETP effluent

18 In many applications the best conventional effluent treatment produces a good water quality (see **Section 2.2.2** on page 48) which may be usable in the process directly or in a mixture with fresh water. While treated effluent quality can vary, it can be recycled selectively, when the quality is adequate, reverting to discharge when the quality falls below that which the system can tolerate. The Operator should confirm the positions in which treated water from the ETP is, or is planned to be, used and justify where it is not.

Tertiary treatment

19 Potable water can be generated by removing the solubles with membrane technology (in-line biological treatment or evaporation techniques could also be used).

20 EXAMPLE
The use of membrane technology in whey processing enables the valuable by-products, whey protein concentrate and lactose concentrate, to be produced. If it includes a reverse osmosis stage, demineralised water suitable for use as boiler feedwater or membrane CIP is produced (Ref. 6)

21 These are well established techniques in other industries and are used in a number of food and drink installations as process steps to recover by-products.

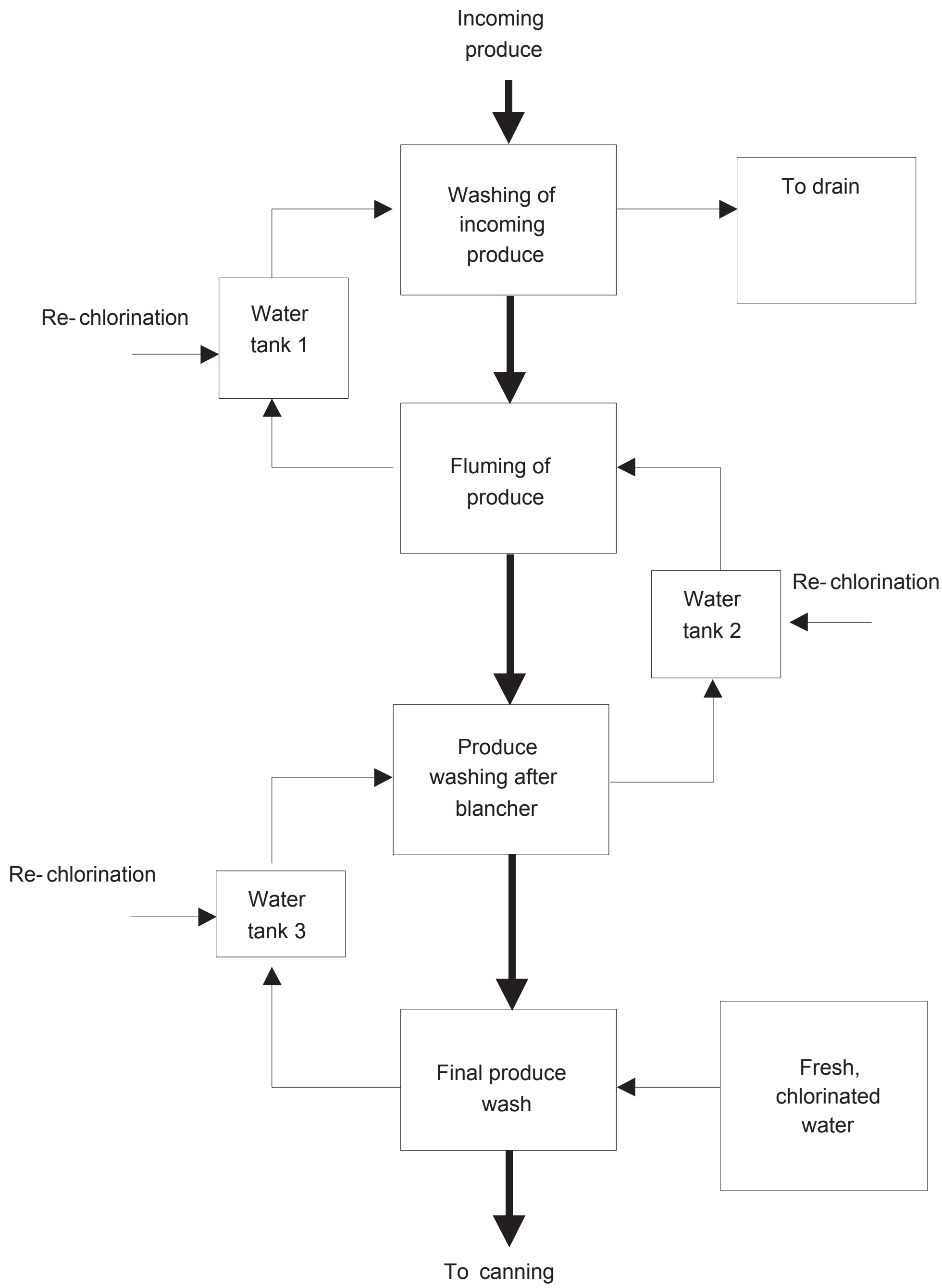
22 Whist membrane techniques are applied in the Food and Drink sector (see **Section 2.1.10.4** on page 39), with one or two exceptions, their widespread implementation to enable water recycling has not taken place. It is accepted that there are several inhibitors to wider application, for example, consumer perception, hygiene requirements and quality considerations (notably in brewing); however there is no technical reason why the use of membrane processes to recycle water should not be an option (see **Figure 2.3**). An assessment of their application should take into account the energy-intensive nature of the technology (see **Section 2.7** on page 86).

23 Targeted application of membrane systems can implement the recycling principles expressed above. The small "footprint" of such systems can be utilised at specific unit process level to recycle process waters. This can minimise contamination from other sources which may rule out re-use and can be used on unit processes which have been identified as significant contributors to the volume and or strength of the effluent.

Indicative BAT requirements for minimisation of water use (Sheet 4 of 4)
Identify the raw and auxiliary materials, other substances and *water* that they propose to use.

24 The cost of membrane technology continues to reduce and these technologies can be applied at the unit process or to the final effluent from the ETP. They can, ultimately, be a complete replacement for the ETP, leading to much reduced effluent volume, and if combined with evaporation using waste heat, lead to potentially effluent-free systems. It is not anticipated that there will be effluent-free installations, although it may be possible to implement closure to specific unit processes and the Operator should assess the costs and benefits of providing tertiary treatment systems.

Figure 2.5: Example of four-stage counter-flow system based on pea cannery



2.5 Waste handling

The Operator 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 - though where there are a very large number of relatively small streams, some aggregation of similar and relatively insignificant waste streams may be appropriate.

In general, the waste streams comprise:

- process wastes specific to the activity
- residues of raw materials and product removed from wastewaters by drainage catchpots and screens
- dust and particulate caught in abatement equipment, for example, cyclones and bag filters
- product wastage, for example, stored product that may have defrosted
- boiler plant ash (some of which may be special waste)

Indicative BAT requirements for waste handling
Characterise and quantify each waste stream and describe the proposed measures for waste management, storage and handling.

1 A system should be in place and maintained which records the quantity, nature and origin of any waste that is disposed of or recovered - and also , where relevant, the destination, frequency of collection, mode of transport and treatment method for those wastes.

2 Wastes should be segregated wherever practicable, and the disposal routes identified. Disposal should be as near to the point of generation as is practicable.

3 Records should be maintained of any waste sent off-site (Duty of Care).

4 All appropriate steps should be taken to prevent emissions from waste storage or handling (eg. liquid or solid spillage, dust or VOC emission, and odour) (see **Section 2.2.4** on page 64, **Section 2.2.5** on page 66 and **Section 2.2.6** on page 67).

Techniques specific to this sector

5 Most of the waste produced by the sector can potentially be recycled into the process, reworked for animal feed, used in landspreading or is suitable for waste treatment methods such as composting. It is therefore important that suitable wastes are identified at an early stage, provision is made for their removal from the process and designated storage areas provided.

2.6 Waste recovery or disposal

The Regulations require the Regulator, in setting Permit conditions, to take account of certain general principles, including that the installation in question should be operated in such a way that "waste production is avoided in accordance with Council Directive 75/442/EEC on waste; and where waste is produced it is recovered, or where this is technically or economically impossible it is disposed of, while avoiding or reducing the impact on the environment". The objectives of the National Waste Strategies should also be considered.

Waste avoidance (minimisation) at source is addressed in detail in **Section 2.1** on page 15 and related issues are addressed in the sections on abatement techniques (see **Section 2.2** on page 44). The specific requirement for a waste minimisation audit is noted in **Section 2.4.2** on page 75.

To meet these requirements, Operators should provide the Regulator with the information requested in point 2 below.

Indicative BAT requirements for waste recovery or disposal

Describe how each waste stream is proposed or disposed of. If you propose any disposal, explain why recovery is technically and economically impossible and describe the measures planned to avoid or reduce any impact on the environment.

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

2 Where waste must be disposed of, the Operator should provide a detailed assessment identifying the best environmental options for waste disposal - unless the Regulator agrees that this is unnecessary. For existing disposal activities, this assessment may be carried out as an improvement condition to a timescale to be approved by the Regulator.

3 The Operator should demonstrate that the chosen routes for recovery or disposal represent the best environmental option considering, but not limited to, the following:

- all avenues for recycling back into the process or reworked for another process
- composting
- animal feed
- other commercial uses, typically as shown in **Table 2.14** on page 85
- landspreading (see Refs. 18 and 19) which should be permitted only where the Operator:
- can demonstrate that it represents a genuine agricultural benefit or ecological improvement
- has identified the pollutants likely to be present from a knowledge of the process, materials of construction, corrosion/erosion mechanisms, materials related to maintenance, for both normal and abnormal operation, validated as necessary by the appropriate analytical techniques
- has identified the ultimate fate of the substances in the soil

4 It should be noted that landspreading will take place under the Waste Management Licensing Regulations 1(3) and 17 Schedule 3 para 7, and the Operator should have a plan and justification for this use (see also MAFF Codes of Good Agricultural Practice). (For Northern Ireland the Codes of Practice are issued by the Department of Agriculture and Rural Development (DARD).)

5 Other wastes are identified and the optimum disposal route identified; in particular, the waste arising from boiler de-ionisation and treatment operations must be specified quantified.

Table 2.14: Potential use for waste

Waste	Potential use
Orange peel	Dietary fibre
Potato pulp	Production of ethanol
Breadcrumbs	Production of sourdough
Brewery grain	Mushroom compost, vermiculture
Fish	Protein hydrolysates
Onions	Onion oil, fructooligosaccharides, pectic polysaccharides, low-lignin dietary fibre

2.7 Energy

BAT for energy efficiency under the PPC Regulations will be satisfied provided the Operator meets the following conditions:

either

- the Operator meets the basic energy requirements in Section 2.7.1 and Section 2.7.2 below and is a participant to a Climate Change Agreement (CCA) or a Direct Participant Agreement (DPA) within the Emissions Trading Scheme.

or

- the Operator meets the basic energy requirements in Section 2.7.1 and Section 2.7.2 below and the further sector-specific energy requirements in Section 2.7.3 below.

Note that even where a Climate Change Agreement or Direct Participant Agreement is in place, this does not preclude the consideration of energy efficiency (including those identified in Section 2.7.3) as part of an integrated assessment of BAT where they impact on other emissions, e.g. where:

- the choice of fuel impacts upon emissions other than carbon, e.g. sulphur in fuel
- the minimisation of waste by waste-to-energy does not maximise energy efficiency, e.g. by Combined Heat and Power (CHP)
- the most energy-intensive abatement leads to the greatest reduction in other emissions

Further guidance is given in the guidance note **H2 Energy efficiency for IPPC**.

2.7.1 Basic energy requirements (1)

The BAT requirements of this section are basic low-cost energy standards that apply whether or not a CCA or DPA is in force for the installation.

Indicative BAT requirements for basic energy requirements (1): (Sheet 1 of 2) Provide a breakdown of the energy consumption and generation by source and the associated environmental emissions.	
1	The Operator should provide annually the energy consumption information, shown in the table below, in terms of delivered energy and also, in the case of electricity, converted to primary energy consumption. For the public electricity supply, a conversion factor of 2.6 should be used. Where applicable, the use of factors derived from on-site heat and/or power generation, or from direct (non-grid) suppliers should be used. In the latter cases, the Operator should provide details of such factors. Where energy is exported from the installation, the Operator should also provide this information. In the application this information should be submitted in the inventory in the H1 software tool and should also supplement this with energy flow information (such as "Sankey" diagrams or energy balances) showing how the energy is used throughout the process.

Indicative BAT requirements for basic energy requirements (1): (Sheet 2 of 2)
Provide a breakdown of the energy consumption and generation by source and the associated environmental emissions.

2 The Operator should provide the following Specific Energy Consumption (SEC) information. Define and calculate the SEC of the activity (or activities) based on primary energy consumption for the products or raw material inputs that most closely match the main purpose or production capacity of the installation. Provide a comparison of SEC against any relevant benchmarks available for the sector. (See BREF and Energy Efficiency Guidance)

3 The Operator should provide associated environmental emissions. This is dealt with in the Operator's response to the emissions inventory using the H1 software tool.

Table 2.15: Example breakdown of delivered and primary energy consumption

Energy source	Energy consumption		
	Delivered, MWh	Primary, MWh	% of total
Electricity*			
Gas			
Oil			
Other (Operator to specify)			

* specify source.

2.7.2 Basic energy requirements (2)

The BAT requirements of this section are basic low-cost energy standards that apply whether or not a CCA or DPA is in force for the installation.

Indicative BAT requirements for basic energy requirements (2) (Sheet 1 of 2)
Describe the proposed measures for improvement of energy efficiency.

1 **Operating, maintenance and housekeeping measures** should be in place in the following areas, where relevant: (Indicative checklists of appropriate measures are provided in Appendix 2 of the guidance note **H2 Energy efficiency for IPPC**.)

- air conditioning, process refrigeration and cooling systems (leaks, seals, temperature control, evaporator/condenser maintenance)
- operation of motors and drives
- compressed gas systems (leaks, procedures for use)
- steam distribution systems (leaks, traps, insulation)
- space heating and hot-water systems
- lubrication to avoid high-friction losses
- boiler operation and maintenance, e.g. optimising excess air
- other maintenance relevant to the activities within the installation

Indicative BAT requirements for basic energy requirements (2) (Sheet 2 of 2)
Describe the proposed measures for improvement of energy efficiency.

2 **Basic low-cost physical techniques** should be in place to avoid gross inefficiencies. These should include insulation, containment methods, (such as seals and self-closing doors), and avoidance of unnecessary discharge of heated water or air (e.g. by fitting simple control systems such as timers and sensors).

3 **Energy-efficient building services** should be in place to deliver the requirements of the Building Services section of the guidance note **H2 Energy efficiency for IPPC**. For energy-intensive industries these issues may be of minor impact and should not distract effort from the major energy issues, but they should nonetheless find a place in the programme, particularly where they constitute more than 5 percent of the total energy consumption.

4 **Energy management techniques** should be in place, according to the requirements of **Section 2.3** on page 70 noting, in particular, the need for monitoring of energy flows and targeting of areas for reductions.

5 **An energy efficiency plan** should be provided that:

- identifies all techniques relevant to the installation, including those listed above and in **Section 2.7.3** on page 89, that are applicable to the installation
- estimates the CO_2 savings that would be achieved by each measure over its lifetime
- and, in the case where the activities are NOT covered by a CCA or DPA; provides information on the equivalent annual costs of implementation of the technique, the costs per tonne of CO_2 saved and the priority for implementation. A procedure is given in the Energy Efficiency Guidance Note.

6 An example format of the energy efficiency plan is shown in **Table 2.16**.

Table 2.16: Example format for energy efficiency plan

ALL APPLICANTS			ONLY APPLICANTS WITHOUT CCA		
Energy efficiency measure	CO_2 savings (tonnes)		Equivalent Annual Cost (EAC) £k	EAC/CO_2 saved £/tonne	Date for implementation
	Annual	lifetime			

The Energy Efficiency Guidance Note provides an appraisal methodology. If Operators use other appraisal methodologies they should state the method in the Application, and provide evidence that appropriate discount rates, asset life and expenditure (£/t) criteria have been employed.

The energy efficiency plan is required to ensure that the Operator has considered all relevant techniques. However, where a CCA or DPA is in place the Regulator will only enforce implementation of those measures in categories 1-3 above.

2.7.3 Further energy-efficiency requirements

Indicative BAT requirements for further energy-efficiency requirements Climate Change Agreement for Trading Agreement.	
1	The following techniques should be implemented where they are judged to be BAT based on a cost/benefit appraisal according to the methodology provided in Appendix 4 of the Guidance Note **H2 Energy efficiency for IPPC**.
2	The following techniques will reduce energy consumption and thereby reduce both direct (heat and emissions from on-site generation) and indirect (emissions from a remote power station) emissions: • heat recovery from, for example ovens, dryers, fryers, evaporators, pasteurisers and sterilisers, where a plate heat exchanger has a regeneration capacity up to 94% • for in-tunnel and tray ovens, heat exchangers should be fitted to the exhaust flues to remove heat from exhaust gases and to heat inlet air • heat recovery from condensed steam, for example, blanching and steam peeling • use of multi-effect evaporators in large scale evaporator applications • minimisation of water use and recirculating water systems • good insulation • plant layout to reduce pumping distances • phase optimisation of electronic control motors • using spent cooling water (which is raised in temperature) in order to recover the heat • scheduling of production to optimise continuous processing instead of batch • optimised efficiency measures for combustion plant, e.g. air/feedwater pre-heating, excess air, etc.
	Energy supply techniques
3	The following techniques should be considered: • use of Combined Heat and Power (CHP) • generation of energy from waste • use of less polluting fuels
4	The Operator should provide justification that the proposed or current situation represents BAT, irrespective of whether or not a CCA or DPA is in place, where there are other BAT considerations involved, eg.: • the choice of fuel impacts upon emissions other than carbon dioxide, eg. sulphur dioxide; • the potential for practical energy recovery from waste conflicts with energy efficiency requirements.
5	Where there is an on-site combustion plant other guidance is also relevant. For plants greater than 50MW, Operators should consult the IPC guidance on power generation (reference IPC S2 1.01 Combustion Processes: Large boilers and furnaces 50MW(th) and over and supplement IPC S3 1.01 Combustion Processes). Operators of plant of 20-50MW should consult the Local Authority Air Pollution Control guidance. On IPPC installations this guidance will be generally applicable to plant under 20MW also. (All are available from the **EA website**).

2.8 Accidents

Guidance

This section covers accidents and their consequences. It is not limited to major accidents but includes spills and abnormal operation.

Some installations will also be subject to the Control of Major Accident Hazards Regulations 1999 (COMAH) (see **Appendix 2** for equivalent legislation in Scotland and Northern Ireland). IPPC and COMAH can sometimes overlap, and some systems and information may be usable for either regime.

The COMAH regime applies to major hazards, and for accident scenarios covered by COMAH , Operators may refer in the Application to any COMAH reports already held by the Regulator. However, the accident provisions under IPPC also cover those which are below the classification threshold for major accidents under COMAH, so Operators need to consider smaller accidents and abnormal operation scenarios as well. Guidance prepared in support of the COMAH Regulations (see the **COMAH guides**), may also help IPPC Operators in considering ways to reduce the risks and consequences of accidents - whether or not they are covered by the COMAH regime.

General management requirements are covered in **Section 2.3** on page 70. For accident management, there are three particular components:

- identification of the hazards posed by the installation/activity
- assessment of the risks (hazard x probability) of accidents and their possible consequences
- implementation of measures to reduce the risks of accidents, and contingency plans for any accidents that do occur

The typical environmental risks associated with this sector are the potential for spillage of high organic strength liquids from leaks, spillages or the overfilling of vessels often compounded by the overloading of the effluent system and cross-connected drainage systems.

Hazardous materials commonly stored on installations include:

- cleaning and sanitisation chemicals
- effluent treatment chemicals
- ammonia and ethylene glycol, and other refrigerants
- fuel

Indicative BAT requirements for accidents and abnormal operations (Sheet 1 of 4) Describe your documented system that you propose to be used to identify, assess and minimise the environmental risks and hazards of accidents and their consequences.	
1	A formal structured accident management plan should be in place which covers the following aspects:
2	**A - Identification of the hazards** to the environment posed by the installation using a methology akin to a Hazop study. Areas to consider should include, but should not be limited to, the following: • transfer of substances (eg. filling or emptying of vessels); • overfilling of vessels; • emissions from plant or equipment (eg. leakage from joints, over-pressurisation of vessels, blocked drains); • failure of containment (eg. physical failure or overfilling of bunds or drainage sumps); • failure to contain firewaters; • wrong connections made in drains or other systems; • incompatible substances allowed to come into contact; • unexpected reactions or runaway reactions;

Indicative BAT requirements for accidents and abnormal operations (Sheet 2 of 4)
Describe your documented system that you propose to be used to identify, assess and minimise the environmental risks and hazards of accidents and their consequences.

- release of an effluent before adequate checking of its composition;
- failure of main services (eg. power, steam, cooling water);
- operator error;
- vandalism.

3 **B - assessment of the risks**. The hazards having been identified, the process of assessing the risks should address six basic questions:

- how likely is the particular evant to occur (source frequency)?
- what substances are released and how much of each (risk evaluation of the event)?
- where do the released substances end up (emission prediction - what are the pathways and receptors)?
- what are the consequences (consequence assessment – what are the effects on the receptors)?
- what are the overall risks (determination of overall risk and its significance to the environment)?
- what can prevent or reduce the risk (risk management – measures to prevent accidents and/or reduce their environmental consequences)?

4 The depth and type of assessment will depend on the characteristics of the installation and its location. The main factors to take into account are:

- the scale and nature of the accident hazard presented by the installation and the activities
- the risks to areas of population and the environment (receptors)
- the nature of the installation and complexity of the activities and the relative difficulty in deciding and justifying the adequacy of the risk-control techniques

5 **C - identification of the techniques necessary to reduce the risks.** The following techniques are relevant to most installations:

- there should be an up-to-date inventory of substances, present or likely to be present, which could have environmental consequences if they escape. This should include apparently innocuous substances that can be environmentally damaging if they escape (for example, a tanker of milk spilled into a watercourse can destroy its ecosystem). The Permit will require the Regulator to be notified of any significant changes to the inventory.
- procedures should be in place for checking and handling raw materials and wastes to ensure compatibility with other substances with which they may accidentally come into contact.
- storage arrangements for raw materials, products and wastes should be designed and operated to minimise risks to the environment.
- there should be automatic process controls backed-up by manual supervision, both to minimise the frequency of emergency situations and to maintain control during emergency situations. Instrumentation will include, where appriopriate, microprocessor control, trips and process interlocks, coupled with independent level, temperature, flow and pressure metering and high or low alarms.
- physical protection should be in place where appropriate (eg. barriers to prevent damage to equipment from the movement of vehicles).
- there should be appropriate secondary containment (eg. bunds, catchpots, building containment).
- techniques and procedures should be in place to prevent overfilling of tanks - lliquid or powder - (eg. level measurement displayed both locally and at the central control point, independent high-level alarms, high-level cut-off, and batch metering).
- where the installation is situated in a floodplain, consideration should be given to techniques which will minimise the risk of the flooding causing a pollution incident or making one worse.

Indicative BAT requirements for accidents and abnormal operations (Sheet 3 of 4)
Describe your documented system that you propose to be used to identify, assess and minimise the environmental risks and hazards of accidents and their consequences.

- security systems to prevent unauthorised access should be provided where appropriate.
- there should be formal systems for the logging and recording of all incidents, near-misses, abnormal events, changes to procedures and significant findings of maintenance inspections.
- there should be procedures for responding to and learning from incidents, near-misses, etc.
- the roles and responsibilities of personnel involved in in incident management should be formally specified.
- clear guidance should be available on how each accident scenario might best be managed (eg. containment or dispersion, to extinguish fires or to let them burn).
- procedures should be in place to avoid incidents occurring as a result of poor communications between staff at shift change or during maintenance or other engineering work.
- safe shutdown procedures should be in place.
- communication channels with emergency services and other relevant authorities should be established, and available for use in the event of an incident. Procedures should include the assessment of harm following an incident and the steps needed to redress this
- appropriate control techniques should be in place to limit the consequences of an accident, such as isolation of drains, provision of oil spillage equipment, alerting of relevant authorities and evacuation procedures.
- personnel training requirements should be identified and training provided.
- the systems for the prevention of fugitive emissions are generally relevant (**Section 2.2.4** on page 64 and **Section 2.2.5** on page 66) and in addition, for drainage systems:
  - procedures should be in place to ensure that the composition of the contents of a bund sump, or sump connected to a drainage system, are checked before treatment or disposal;
  - drainage sumps should be equipped with a high-level alarm or with a sensor and automatic pump to storage (not to discharge);
  - there should be a system in place to ensure that sump levels are kept to a minimum at all times;
  - high-level alarms and similar back-up instruments should not be used as the primary method of level control.
- duplicate or standby plant should be provided where necessary, with maintenance and testing to the same standards as the main plant;
- spill contingency procedures should be in place to minimise accidental release of raw materials, products and waste materials and then to prevent their entry into water.
- process waters, potentially contaminated site drainage waters, emergency firewater, chemically-contaminated waters and spillages of chemicals should be contained and, where necessary, routed to the effluent system and treated before emission to controlled waters or sewer. Sufficient storage should be provided to ensure that this can be achieved. Any emergency firewater collection system should take account of the additional firewater flows and fire-fighting foams, and emergency storage lagoons may be needed to prevent contaminated firewater reaching controlled waters (see the **Releases to water references**).
- consideration should be given to the possibility of containment or abatement of accidental emissions from vents and safety relief valves/bursting discs. Where this may be inadvisable on safety grounds, attention should be focused on reducing the probability of the emission.

Indicative BAT requirements for accidents and abnormal operations (Sheet 4 of 4)
Describe your documented system that you propose to be used to identify, assess and minimise the environmental risks and hazards of accidents and their consequences.

Sector-specific techniques

6 The following techniques are sector-specific.

- Ensure that gross FOG does not block drains.
- Interlock chemical dosing pumps with cleaning operations in order to prevent continued dosing after cessation of cleaning.
- The Operator should have identified the major risks associated with the ETP and have in place procedures which minimise the risks, such as bulking or other breakdown of the waste-water treatment plant, and which deal with these events if they occur, including reducing load if necessary.
- Provide of adequate effluent buffer storage to prevent spills reaching the ETP or controlled water.

2.9 Noise

Within this section “noise” should be taken to refer to “noise and/or vibration” as appropriate, detectable beyond the site boundary.

Where noise issues are likely to be relevant, the Operator will be required, in the Application, to provide information on the following: (for more details see **H3 Part 1 Noise**)

- the main sources of noise and vibration that will fall within the IPPC installation and also on Infrequent sources of noise and vibration
- the nearest noise-sensitive sites
- conditions/limits imposed under other regimes
- the local noise environment
- any environmental noise measurement surveys, modelling or any other noise measurements
- any specific local issues and proposals for improvements.

The level of detail supplied should be in keeping with the risk of causing noise-related annoyance at sensitive receptors.

Where an installation poses no risk of noise-related environmental impact because the activities undertaken are inherently quiet, this should be justified and no further information relating to noise need normally be supplied. It should, however, be remembered that there can still be an underlying level of annoyance without complaints being made.

The PPC Regulations require installations to be operated in such a way that “all the appropriate preventative measures are taken against pollution, in particular through the application of BAT”. The definition of pollution includes “emissions that may be harmful to human health or the quality of the environment, cause offence to human senses or impair or interfere with amenities and other legitimate uses of the environment”. BAT is therefore likely to be similar, in practice, to the requirements of the statutory nuisance legislation, which requires the use of “best practicable means” to prevent or minimise noise nuisance. It is understood that raw material handling can generate noise where glass is being recycled or broken up. It is suggested that consideration be given to the use of sonic booths or sound proofing to control the generation of noise where such activities are being carried out.

In the case of noise, “offence to any human senses” can normally be judged by the likelihood of complaints, but in some cases it may be possible to reduce noise emissions still further at reasonable costs, and this may exceptionally therefore be BAT for noise emissions.

For advice on how noise and/or vibration related limits and conditions will be determined see **H3 Part 1 Noise**

Indicative BAT requirements for noise and vibration (Sheet 1 of 2) Describe the main sources of noise and vibration (including infrequent sources); the nearest noise-sensitive locations and relevant environmental surveys which have been undertaken; and the proposed techniques and measures for the control of noise.	
1	The Operator should employ basic good practice measures for the control of noise, including adequate maintenance of any parts of plant or equipment whose deterioration may give rise to increases in noise (for example, maintenance of bearings, air handling plant, the building fabric as well as specific noise attenuation measures associated with plant, equipment or machinery).

Indicative BAT requirements for noise and vibration (Sheet 2 of 2)
Describe the main sources of noise and vibration (including infrequent sources); the nearest noise-sensitive locations and relevant environmental surveys which have been undertaken; and the proposed techniques and measures for the control of noise.

2 The Operator should also employ such other noise control techniques to ensure that the noise from the installation does not give rise to reasonable cause for annoyance, in the view of the Regulator and, in particular, should justify where either Rating Levels (LAeq,T) from the installation exceed the numerical value of the Background Sound Level (LA90,T).

3 Further justification will be required should the resulting field rating level (LAR,TR) exceed 50 dB by day and a facade rating level exceed 45 dB by night, with day being defined as 07:00 to 23:00 and night 23:00 to 07:00.

4 In some circumstances "creeping background" may be an issue. Where this has been identified in pre application discussions or in previous discussions with the local authority, the Operator should employ such noise control techniques as are considered appropriate to minimise problems to an acceptable level within the BAT criteria.

5 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. Operators may have a noise management plan as part of their management system.

2.10 Monitoring

This section describes monitoring and reporting requirements for emissions to all environmental media. Guidance is provided for selecting the appropriate monitoring methodologies, frequency of monitoring, compliance-assessment criteria and environmental monitoring.

2.10.1 Emissions monitoring

Indicative BAT requirements for emissions monitoring (Sheet 1 of 2)
Describe the proposed measures for monitoring emissions, including any environmental monitoring, and the frequency, measurement methodology and evaluation procedure proposed.

1 The following monitoring parameters and frequency are normally appropriate in this sector. Generally, monitoring should be undertaken during commissioning, start-up, normal operation and shut-down unless the Regulator agrees that it would be inappropriate to do so.

2 Continuous monitoring (or at least sampling in the case of water) and recording are likely to be required under the following circumstances:
- Where the potential environmental impact is significant or the concentration of substance varies widely.
- Where a substance is abated continuous monitoring of the substance is required to show the performance of the abatement plant. For example continuous monitoring of dust is needed after a fabric filter to show the effectiveness of the filter and indicate when maintenance is needed, or sampling BOD from an effluent treatment plant.
- Where other control measures are required to achieve satisfactory levels of emission (e.g. material selection).

3 Where effective surrogates are available, they may be used to minimise monitoring costs.

4 Where monitoring shows that substances are not emitted in significant quantities, it may be possible to reduce monitoring frequency.

5 For analysis techniques and compliance criteria see **Appendix 1**.

Monitoring and reporting of emissions to water and sewer

6 Monitoring of process effluents released to controlled waters should include at least the parameters in **Table 2.17** on page 97. Monitoring of process effluents released to sewer should include at least the parameters in **Table 2.18** on page 97.

Monitoring and reporting of emissions to air

7 Where appropriate, periodic visual and olfactory assessment of releases should be undertaken to ensure that all final releases to air should be essentially colourless, free from persistent trailing mist or fume and free from droplets.

Indicative BAT requirements for emissions monitoring (Sheet 2 of 2)
Describe the proposed measures for monitoring emissions, including any environmental monitoring, and the frequency, measurement methodology and evaluation procedure proposed.

8 The Operator should also have a fuller analysis carried out covering a broad spectrum of substances to establish that all relevant substances have been taken into account when setting the release limits. This should cover the substances listed in Schedule 5 of the Regulations unless it is agreed with the Regulator that they are not applicable. 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.

9 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, should also be monitored more regularly. 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.

10 In some sectors there may be releases of substances that are more difficult to measure and whose capacity for harm is uncertain, particularly when combined with other substances. "Whole effluent toxicity" monitoring techniques can therefore be appropriate to provide direct measurements of harm, for example, direct toxicity assessment. See **Section 2.2.2** on page 48.

Monitoring and reporting of waste emissions

11 For waste emissions, the following should be monitored and recorded:

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

12 The Operator should identify the substances which will be released from each source, and quantify them, to enable the Agency to determine which, if any, will require regular monitoring. Although dependent upon the individual plant, the environmental significance of the released substances and the presence of sensitive receptors, monitoring is most likely to be needed for the substances/sources given in **Table 2.19** on page 98.

Table 2.17: Monitoring of process effluents released to watercourses

Parameter	Monitoring frequency
Flow rate	Continuous and integrated daily flow rate
pH	Continuous
Temperature	Continuous
COD/BOD	Flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages
TOC	Continuous
Turbidity	Continuous
Dissolved oxygen	Continuous

Table 2.18: Monitoring of process effluents released to sewer

Parameter	Monitoring frequency
Flow rate	Continuous and integrated daily flow rate
pH	Continuous

Table 2.18: Monitoring of process effluents released to sewer

Parameter	Monitoring frequency
Temperature	Dependent on process. If process may generate an effluent >25^{o}C, continuous monitoring would be appropriate
COD/BOD	Flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages
TOC	Continuous

Table 2.19: Monitoring substances released from sources

Substance/sources	Frequency
Particulate from, for example, the receiving and handling of raw materials, dry cleaning, mixing of powders, evaporators, dryers and grinding (milling)	Quarterly
VOCs from, for example, peeling, extrusion, blanching, evaporators, dryers and solvent extraction	Quarterly
Combustion emissions	See separate Guidance

2.10.2 Environmental monitoring (beyond installation)

Indicative BAT requirements for environmental monitoring (beyond installation)

Describe the proposed measures for monitoring emissions, including any environmental monitoring, and the frequency, measurement methodology and evaluation procedure proposed.

1 The Operator should consider the need for environmental monitoring to assess the effects of emissions to controlled water, groundwater, air or land, or emissions of noise or odour.

2 Environmental monitoring may be required, for example, when:
- there are vulnerable receptors
- the emissions are a significant contributor to an Environmental Quality Standard (EQS) that may be at risk
- the Operator is looking for departures from standards based on lack of effect on the environment;
- to validate modelling work.

3 The need should be considered for:
- groundwater, where it should be designed to characterise both quality and flow and take into account short- and long-term variations in both. Monitoring will need to take place both up-gradient and down-gradient of the site
- surface water, where consideration will be needed for sampling, analysis and reporting for upstream and downstream quality of the controlled water
- air, including odour
- land contamination, including vegetation, and agricultural products
- assessment of health impacts
- noise

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

5 Guidance on air quality monitoring strategies and methodologies can be found in **Monitoring Guidance**.
- For food and drink installations discharging to controlled waters, environmental monitoring programmes are usually needed.

2.10.3 Monitoring of process variables

Indicative BAT requirements for monitoring of process variables Describe the proposed measures for monitoring emissions, including any environmental monitoring, and the frequency, measurement methodology and evaluation procedure proposed.	
1	Some process variables may affect the environment and these should be identified and monitored as appropriate. Examples might be:
2	as shown in **Table 2.20** below.

Table 2.20: Monitoring of process variables

Process variable	Comment	Monitoring frequency
Product loss or wastage	See **Section 2.1.1** on page 15 Monitoring of parameters such as TOC on emissions to sewer can be used to monitor these process variables.	Activity-specific
Freshwater use across the installation and at individual points of use	See **Section 2.4.3** on page 78	normally continuous and recorded
Energy consumption across the installation and at individual points of use		normally continuous and recorded
Refrigerants	Quantity of refrigerant and oil added to or removed from the system (see **Section 2.1.9** on page 33).	each charge or drain
Cleaning	Monitoring of use of cleaning agents and chemicals to check that correct dilutions and application procedures are being followed. CIP Manual	normally continuous and recorded for CIP weekly

2.10.4 Monitoring standards (Standard Reference Methods)

The Environment Agency has introduced its Monitoring Certification Scheme (MCERTS) to improve the quality of monitoring data and to ensure that the instrumentation and methodologies employed for monitoring are fit for purpose. Performance standards have been published for continuous emissions monitoring systems (CEMs), ambient air quality monitoring systems (CAMs) , chemical testing of soils and manual stack emissions monitoring. Other MCERTS standards are under development to cover portable emissions monitoring equipment, water monitoring instrumentation, data acquisition and Operators' own arrangements, such as installation, calibration and maintenance of monitoring equipment, position of sampling ports and provision of safe access for manual stack monitoring.

The following should be described in the application, indicating which monitoring provisions comply with MCERTS requirements or where other arrangements have been made:

- monitoring methods and procedures (selection of Standard Reference Methods)

- justification for continuous monitoring or spot sampling
- reference conditions and averaging periods
- measurement uncertainty of the proposed methods and the resultant overall uncertainty
- criteria for the assessment of non-compliance with Permit limits and details of monitoring strategy aimed at demonstration of compliance
- reporting procedures and data storage of monitoring results, record keeping and reporting intervals for the provision of information to the Regulator
- procedures for monitoring during start-up and shut-down and abnormal process conditions
- drift correction calibration intervals and methods
- the accreditation held by samplers and laboratories or details of the people used and the training/ competencies

Indicative BAT requirements for monitoring standards (Standard Reference Methods) (Sheet 1 of 2)
Describe the proposed measures for monitoring emissions, including any environmental monitoring, and the frequency, measurement methodology and evaluation procedure proposed.

1 As far as possible, Operators should ensure their monitoring arrangements comply with the requirements of MCERTS where available, for example using certified instruments and equipment, and using a stack testing organisation accredited to MCERTS standards. Where the monitoring arrangements are not in accordance with MCERTS requirements, the Operator should provide justification and describe the monitoring provisions in detail. See **MCERTS approved equipment** for future information on MCERTS and a listing of MCERTS equipment.

Sampling and analysis standards

2 The analytical methods given in **Appendix 1** should be used. If other substances need to be monitored the standard should be selected in the order of priority as given in the IPPC Bureau's Reference Document on the General Principles of Monitoring. This order is:
- Comitee Europeen de Normalisation (CEN)
- International Standardisation Organisation (ISO)

3 If the substance cannot be monitored using CEN or ISO standards then a method can be selected from any one of the following
- American Society for Testing and Materials (ASTM)
- Association Francaise de Normalisation (AFNOR)
- British Standards Institution (BSI)
- Deutsches Institute fur Normung (DIN
- United States Environmental Protection Agency (US EPA)
- Verein Deustcher Ingenieure (VDI)

4 If the substance cannot be monitored using any of the standards above then other methods may be adapted for use, following the requirements for validation in ISO 17025. For stack emission monitoring the following occupational methods may be adapted:
- Methods for the Determination of Hazardous Substances (MHDS) series published by the Health and Safety Executive (HSE)
- National Institute for Occupational Safety and Health (NIOSH)
- Occupational Safety and Health Administration (OSHA)

5 The intended application of the standard method must always be taken into account. For example, a CEN method may be less suitable than another less-rigorously validated standard method if the application is not one for which the CEN method was developed.

Indicative BAT requirements for monitoring standards (Standard Reference Methods) (Sheet 2 of 2) Describe the proposed measures for monitoring emissions, including any environmental monitoring, and the frequency, measurement methodology and evaluation procedure proposed.	
6	Operators should be expected to be able to demonstrate compliance with the above hierarchy and validate use of non-standard methods, in-house designed/developed methods, standard methods used outside their intended scope and modifications of standard methods to confirm that these methods are fit for purpose.
7	Further guidance on standards for monitoring gaseous releases relevant to IPC/IPPC is given in the **Monitoring Guidance**. A series of updated Guidance Notes covering this subject is being prepared. This guidance specifies manual methods of sampling and analysis that will also be suitable for calibration of continuous emission monitoring instruments. Further guidance relevant to water and waste is available from the publications of the Standing Committee of Analysts.
8	If in doubt the Operator should consult the Regulator.

2.11 Closure

The PPC Regulations require an Applicant to submit a site report, describing the condition of the site, as part of the application. Guidance on this is in Annex C of the Guide for Applicants (see **IPPC Part A(1) Installations: Guide for (Applicants England and Wales) (includes Preparation of a Site Report in a Permit Application) (EA website).**) or Guidance for SEPA Staff On Land and Groundwater Considerations for PPC Part A Installations (Scotland) (see **PPC Part A Installations: Guide for Applicants (Scotland)**).

Indicative BAT requirements for closure (Sheet 1 of 2)
Describe the proposed measures, upon definitive cessation of activities, to avoid any pollution risk and return the site of operation to a satisfactory state (including where appropriate, measures relating to the design and construction oft he installation.

1 **Operations during the IPPC Permit**
Operations during the life of the IPPC Permit should not lead to any deterioration of the site if the requirements of the other sections of this and the specific-sector notes are adhered to. Should any instances arise which have, or might have, impacted on the state of the site, the Operator should record them along with any further investigation or ameliorating work carried out. This will ensure that there is a coherent record of the state of the site throughout the period of the IPPC Permit. This is as important for the protection of the Operator as it is for the protection of the environment. Any changes to this record should be submitted to the Regulator.

2 **Steps to be taken at the design-and-build stage of the activities**
Care should be taken at the design stage to minimise risks during decommissioning. For existing installations, where potential problems are identified, a programme of improvements should be put in place to a timescale agreed with the Regulator. Designs should ensure that:
- underground tanks and pipework are avoided where possible (unless protected by secondary containment or a suitable monitoring programme)
- there is provision for the draining and clean-out of vessels and pipework prior to dismantling
- lagoons and landfills are designed with a view to their eventual clean-up or surrender
- insulation is provided that is readily dismantled without dust or hazard
- materials used are recyclable (having regard for operational or other environmental objectives)

3 **The site-closure plan**
A site closure plan should be maintained to demonstrate that, in its current state, the installation can be decommissioned to avoid any pollution risk and return the site of operation to a satisfactory state. The plan should be kept updated as material changes occur. Common sense should be used in the level of detail, since the circumstances at closure will affect the final plans. However, even at an early stage, the closure plan should include:
- either the removal or the flushing out of pipelines and vessels where appropriate and their complete emptying of any potentially harmful contents
- plans of all underground pipes and vessels
- the method and resource necessary for the clearing of lagoons
- the method of ensuring that any on-site landfills can meet the equivalent of surrender conditions
- the removal of asbestos or other potentially harmful materials unless agreed that it is reasonable to leave such liabilities to future owners
- methods of dismantling buildings and other structures, see **Closure references** which gives guidance on the protection of surface and groundwater at construction and demolition-sites

Indicative BAT requirements for closure (Sheet 2 of 2)
Describe the proposed measures, upon definitive cessation of activities, to avoid any pollution risk and return the site of operation to a satisfactory state (including where appropriate, measures relating to the design and construction oft he installation.

- testing of the soil to ascertain the degree of any pollution caused by the activities and the need for any remediation to return the site to a satisfactory state as defined by the initial site report

4 For existing activities, the Operator should complete any detailed studies, and submit the site-closure plan as an improvement condition to a timescale to be agreed with the Regulator but in any case within the timescale given in **Section 1.1** on page 1 (Note that radioactive sources are not covered by this legislation, but decommissioning plans should be co-ordinated with responsibilities under the Radioactive Substances Act 1993.)

2.12 Installation issues

In some cases it is possible that actions that benefit the environmental performance of the overall installation will increase the emissions from one Permit-holder's activities. For example, taking treated effluent as a raw water supply will probably slightly increase emissions from that activity, but could dramatically cut the total emissions from the whole installation.

Where you are not the only Operator of the installation, describe the proposed techniques and measures (including those to be taken jointly by yourself and other Operators) for ensuring the satisfactory operation of the whole installation

Indicative BAT requirements for installation wide issues
Where you are not the only Operator of the installation, describe the proposed techniques and measures (including those to be taken by yourself and other Operators) for ensuring the satisfactory operation of the whole installation.

1 The Operator should consider possibilities for minimising environmental impact to the environment as a whole, by operating together with other Permit holders. Possibilities include:
- Communication procedures between the various Permit-holders; in particular those needed to ensure that the risk of environmental incidents is minimised.
- Benefiting from the economies of scale to justify the installation of a CHP plant.
- The combining of combustible wastes to justify a combined waste-to-energy/CHP plant.
- The waste from one activity being a possible feedstock for another.
- The treated effluent from one activity being of adequate quality to be the raw water feed for another activity.
- The combining of effluent to justify a combined or upgraded effluent-treatment plant.
- The avoidance of accidents from one activity that may have a detrimental knock-on effect on the neighbouring activity.
- Land contamination from one activity affecting another – or the possibility that one Operator owns the land on which the other is situated.

3 Emission benchmarks

3.1 Emissions inventory

The Regulations require the Applicant to describe the nature, quantities and sources of foreseeable emissions into each medium. This will be done by completing the inventory of emission and consumption in the H1 software tool. The information required is as follows.

Provide a table of significant emissions of substances (except noise, vibration, odour and heat which are covered in their respective sections) that will result from the proposals and should include, preferably in order of significance:

- substance (where the substance is a mixture, for example, VOCs or COD, separate identification of the main constituents or inclusion of an improvement proposal to identify them)
- source, including height, location and efflux velocity
- media to which it is released
- any relevant EQS or other obligations
- benchmark
- proposed emissions normal/max expressed, as appropriate for:
  - mass/unit time
  - concentration
  - annual mass emissions
- statistical basis (average, percentile etc.)
- notes covering the Operators confidence in his ability to meet the benchmark values
- if intermittent, the appropriate frequencies
- plant loads at which the data is applicable
- whether measured or calculated (the method of calculation should be provided)

The response should clearly state whether the emissions are current emission rates or those planned following improvements, and should cover emissions under both normal and abnormal conditions for:

- point-source emissions to surface water, groundwater and sewer
- waste emissions
- point-source emissions to air
- significant fugitive emissions to all media, identifying the proportion of each substance released that is due to fugitives rather than point-source releases
- abnormal emissions from emergency relief vents, flares and the like
- indirect and direct emission of carbon dioxide associated with energy consumed or generated

Emissions of carbon dioxide associated with energy use should be broken down by energy type and, in the case of electricity, by source, for example, public supply, direct supply or on-site generation. Where energy is generated on-site, or from a direct (non-public) supplier, the Operator should specify and use the appropriate factor. Standard factors for carbon dioxide emissions are provided in the guidance note **H2 Energy efficiency for IPPC**.

Where VOCs are released, the main chemical constituents of the emissions should be identified.

For waste, emissions relate to any wastes removed from the installation, or disposed of at the installation under the conditions of the Permit, for example, landfill. Each waste should have its composition determined and the amounts expressed in terms of cubic metres or tonnes per month. A suitable table on which to record this information is provided in the electronic version of this Guidance Note.

Indicative BAT requirements for emission benchmarks
Describe the nature, quantities and sources of foreseeable emissions into each medium (which will result from the techniques proposed in Section 2).

1. The Operator should compare the emissions with the benchmark values given in the remainder of this Section.
2. Where the benchmarks are not met, the Operator should revisit the responses made in Section 2 as appropriate and make proposals for improvements or justify not doing so as part of the BAT assessment.

3.2 Emission benchmarks

Introduction to emission benchmarks

Guidance is given below on release concentrations or mass release rates achievable for key substances using the best combination of techniques. These BAT-based benchmarks are not mandatory release limits and reference should be made to Section 1 and the Guide for Applicants regarding their use.

3.2.1 Emissions to air associated with the use of BAT

The emissions quoted below are daily averages based upon continuous monitoring during the period of operation. See **Section 3.2.6** on page 111 for the standard conditions that should be applied. Care should always be taken to convert benchmark and proposed releases to the same reference conditions for comparison. To convert measured values to reference conditions, see the **Monitoring Guidance** for more information. The benchmarks given do not take sampling, analytical errors, or uncertainties into account. These will be considered when setting an ELV for a Permit.

Limits in Permits may be set for mean or median values over long or short periods. The periods and limits selected should reflect:

- the manner in which the emission may impact upon the environment
- likely variations which will arise during operation within BAT
- possible failure modes and their consequences
- the capabilities of the monitoring and testing system employed

Where emissions are expressed in terms of concentrations and where continuous monitors are employed, it is recommended that limits are defined such that:

- not more than one calendar monthly average during any rolling twelve month period shall exceed the benchmark value by more than 10%
- not more than one half hour period during any rolling 24 hour period shall exceed the benchmark value by more than 50% (for the purpose of this limit half hourly periods commence on the hour and the half hour)

Where spot tests are employed:

- the half hour limit above shall be applied over the period of the test
- the mean of three consecutive tests taken during a calendar year shall not exceed the benchmark value by more than 10%

3.2.2 Emissions to water associated with the use of BAT

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

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

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

Where spot samples are taken:

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

3.2.3 Standards and obligations

In addition to meeting the requirements of BAT, there are other national and international standards and obligations that must either be safeguarded through the IPPC Permit or, at least, taken into account in setting Permit conditions. This is particularly the case for any EC-based EQSs.

EC-based EQ standards

IPPC: A Practical Guide explains how these should be taken into account and contains an annex listing the relevant standards. (See **Appendix 2** for equivalent legislation in Scotland and Northern Ireland). They can be summarised as follows:

Air quality

- Statutory Instrument 2000 No.928, Air Quality (England) Regulations 2000 gives air quality objectives to be achieved by:
  – 2005 for nitrogen dioxide
  – 2004 for SO2 and PM10
  – 2003 for CO, 1,3-butadiene and benzene
  – in two stages for lead by 2004 and 2008 respectively
- Statutory Instrument 2002 No. 3043 The Air Quality (England) (Amendment) Regulations 2002, which sets a tighter objective for CO and a longer-term objective for benzene to be achieved by 2010.

Water quality

- Directive 76/464/EEC on Pollution Caused by Dangerous Substances Discharged to Water contains two lists of substances. List I relates to the most dangerous, and standards are set out in various daughter Directives. List II substances must also be controlled. Annual mean concentration limits for receiving waters for List I substances can be found in SI 1989/2286 and SI 1992/337 the Surface Water (Dangerous Substances Classification) Regulations. Values for List II substances are contained in SI 1997/2560 and SI 1998/389. Daughter Directives cover EQS values for mercury, cadmium, hexachlorocyclohexane, DDT, carbon tetrachloride, pentachlorophenol, aldrin, dieldrin, endrin, isodrin, hexachlorobenzene, hexachlorobutadiene, chloroform,1,2-dichloroethane, trichloroethane, perchloroethane and trichlorobenzene.
- Other waters with specific uses have water quality concentration limits for certain substances. These are covered by the following Regulations:

- SI 1991/1597 Bathing Waters (Classification) Regulations
- SI 1992/1331 and Direction 1997 Surface Waters (Fishlife) (Classification) Regulations
- SI 1997/1332 Surface Waters (Shellfish) (Classification) Regulations
- SI 1996/3001 The Surface Waters (Abstraction and Drinking Water) (Classification) Regulations

Future likely changes include:

- Some air quality and water quality standards may be replaced by new ones in the near future.
- The SED on the limitation of emissions of VOCs due to the use of organic solvents in certain activities and installations.

Other standards and obligations

Those most frequently applicable to most sectors are:

- Hazardous Waste Incineration Directive
- Waste Incineration Directive.
- Large Combustion Plant Directive.
- Reducing Emissions of VOCs and Levels of Ground Level Ozone: a UK Strategy (published by the Department of the Environment in October 1993. It sets out how the Government expects to meet its obligations under the UNECE VOCs Protocol to reduce its emissions by 30% (based on 1988 levels) by 1999, including the reductions projected for the major industrial sectors).
- Water Quality Objectives – assigned water quality objectives to inland rivers and water courses (ref. Surface (Rivers Ecosystem) Classification).
- The UNECE convention on long-range transboundary air pollution (negotiations are now underway which could lead to a requirement further to reduce emissions of NOx and VOCs. A requirement to further reduce SO2 emissions from all sources has been agreed. The second Sulphur protocol (Oslo, 1994) obliges the UK to reduce SO2 emissions by 80% (based on 1980 levels) by 2010).
- The Montreal Protocol.
- The Habitats Directive (see **Section 4.3** on page 125).
- Sulphur Content of Certain Liquid Fuels Directive 1999/32/EC (from 1 January 2003, the sulphur content of heavy fuel oil must not exceed 1% except when it is burnt in plants fitted with SO2 abatement equipment. Sulphur levels in gas oil must not exceed 0.2% from 1 July 2000, and 0.1% from the start of 2008.)

3.2.4 Units for benchmarks and setting limits in permits

Releases can be expressed in terms of:

- **"concentration"** (for example mg/l or mg/m3), which is a useful day-to-day measure of the effectiveness of any abatement plant and is usually measurable and enforceable The total flow must be measured/controlled as well
- **"specific mass release"** (for example, kg/ product or input or other appropriate parameter), which is a measure of the overall environmental performance of the plant (including the abatement plant) compared with similar plants elsewhere
- **"absolute mass release"** (for example, kg/hr, t/yr), which relates directly to environmental impact

When endeavouring to reduce the environmental impact of an installation, its performance against each of these levels should be considered, as appropriate to the circumstances, in assessing where improvements can best be made.

When setting limits in Permits, the most appropriate measure will depend on the purpose of the limit. It may also be appropriate to use surrogate parameters, which reflect optimum environmental performance of plant as the routine measurement, supported by less frequent check-analyses on the final concentration. Examples of surrogate measures would be the continuous measurement of conductivity (after ion-exchange treatment) or total carbon (before a guard-column in activated carbon treatment) to indicate when regeneration or replacement is required.

The emission level figures given in this chapter are based on average figures, not on maximum, short-term peak values, which could be expected to be higher. The emission levels given are based on a typical averaging period of not less than 30 minutes and not greater than 24 hours.

3.2.5 Statistical basis for benchmarks and limits in permits

Conditions in Permits can be set with percentile, mean or median values over annual, monthly or daily periods, which reflect probable variation in performance. In addition, absolute maxima can be set.

Where there are known failure modes, which will occur even when applying BAT, limits in Permits may be specifically disapplied, but with commensurate requirements to notify the Regulator and to take specific remedial action.

For water: UK benchmarks or limits are most frequently 95 percentile concentrations or absolute concentrations, (with flow limited on a daily average or maximum basis).

For air: benchmarks or limits are most frequently expressed as daily averages or, typically 95 percent of hourly averages.

3.2.6 Reference conditions for releases to air

The reference conditions of substances in releases to air from point-sources are:

The reference conditions of substances in releases to air from point sources are: temperature 273 K (0^{o}C), pressure 101.3 kPa (1 atmosphere), no correction for water vapour or oxygen.

The reference conditions for combustion or incineration processes are as given in the appropriate Guidance Note.

These reference conditions relate to the benchmark release levels given in this Note, and care should always be taken to convert benchmark and proposed releases to the same reference conditions for comparison. The Permit may employ different reference conditions if they are more suitable for the process in question.

To convert measured values to reference conditions, see Technical Guidance Note M2 (Ref. 22) for more information.

To convert measured values to reference conditions, see the **Monitoring Guidance** for more information.

3.3 Biochemical oxygen demand

This is relevant for emissions to water, including sewer.

Other applicable standards and obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.)

Table 3.1: Biochemical oxygen demand: water quality objectives in England, Wales and Northern Ireland

Water quality objectives England, Wales and Northern Ireland	BOD (ATU) (mg/l, 90%ile)	Dissolved O2 (% saturation, 10%ile)
Class 1	2.5	80
Class 2	4.0	70
Class 3	6.0	60
Class 4	8.0	40
Class 5	15	20
Designated freshwaters SI 1997/1331		Dissolved O2 (mg/l) *
Salmonid imperative: guideline:	- 3	50%>9 50%>9, 100%>7
Cyprinid imperative: guideline:	- 6	50%>7 50%>9, 100%>5

- * 50% median and 100% minimum standard.

Table 3.2: Biochemical oxygen demand: water quality objectives in Scotland

Water quality objectives Scotland	BOD (ATU) (mg/l, 90%ile)	Dissolved O2 (% saturation, 10%ile)
Class Excellent	<2.5	>80
Class Good	<4	>70
Class Fair	<6	>60
Class Poor	<15	>20
Class Seriously Polluted	>15	<20
Designated freshwaters SI 1997/2471		Dissolved O2 (mg/l)*
Salmonid imperative guideline	- 3	50%ile>9 50%ile>9, 100%>7
Cyprinind imperative guideline	- 6	50%ile>7 50%ile>9, 100%>5

* 50% median and 100% minimum standard.

Benchmark emission values

The BOD benchmarks are obviously important where a treated effluent is being discharged to a watercourse. Such a benchmark is also an important measure where the effluent is to be treated off-site (see **Section 2.2.5** on page 66) where the Operator has to assess the off-site treatment against what could be carried out on-site under BAT criteria.

On-site biological treatment plant can be designed to deliver a concentration of 10–20 mg/l (flow-weighted monthly average), for any incoming load. The mass release will therefore be determined by the water flow. Minimisation of water usage would therefore be important. Lower values can be achieved by filtration as secondary or tertiary treatment.

For new plant discharging to controlled water, 10–20 mg/l represents BAT in the general case. Existing plant should be up-rated to meet at least the larger values in the ranges for the appropriate plant in the above table.

In specific cases it may be possible to demonstrate that BAT does not require these levels. Such a case should be based upon:

- understanding of the chemical composition of the discharge, in particular the lack of persistent, bio-accumulative, or toxic elements which could have been removed by further treatment
- a knowledge of the local environment and an assessment of the likely impact thereon
- an appropriate environmental monitoring programme to demonstrate that there is no significant impact

3.4 Chemical oxygen demand

Other applicable standards and obligations

None.

Benchmark emission values

Not available.

Emission limit values would normally only be set if the impact of the COD was understood and there is a clear reason for setting the limit such as to drive a reduction to an agreed plan, as a toxicity surrogate or where there are agreed actions which can be employed to control it. Thus it is more important that there is:

- an understanding of the chemical composition of the discharge, in particular the lack of persistent, bioaccumulative, or toxic elements which could have been removed by further treatment
- a knowledge of the local environment and an assessment of the likely impact thereon
- an appropriate environmental monitoring programme to demonstrate that there is no significant impact

3.5 Halogens

Other applicable standards and obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.)

Table 3.3: Halogen standards

	Total residual chlorine (as mg/l HOCl)
Designated freshwaters SI 1997/1331	
Salmonid imperative: guideline:	0.005 -
Cyprinid imperative: guideline:	0.005 -
Dangerous Substances List 1 (Fresh or tidal)	

Benchmark emission values

Table 3.4: Benchmark emission values

Media	Substance	Activity	Benchmark value	Basis for the benchmark
To air	HCl and HF	Combustion/incineration	See appropriate Guidance	

3.6 Heavy metals

Other applicable standards and obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.)

Table 3.5: Heavy metal standards

	Zinc and copper	Mercury	Cadmium
		(µg (as metal)/l annual average)	
Designated freshwaters SI 1997/1331 UK water quality objectives	Depends on water hardness – see Regulations and Note 1		
Dangerous Substances emission limits List 1 Fresh: Coastal:		 1.0 0.3	 5 2.5
Dangerous Substances emission limits List 2 (Fresh or tidal)	Most metals – see Note 1		

Note 1: Unless these metals are known to be used – from assessment of raw materials inventory or from a one-off analysis (see **Section 2.10** on page 96), further monitoring or emission limit values are not normally required.

Benchmark emission values

Where sources of mercury or cadmium cannot be eliminated or reduced to the above by control at source, abatement will be required to control releases to water. In biological treatment 75–95% of these metals will transfer to the sludge. Levels are unlikely to cause problems for the disposal of sludge, but care will need to be taken to ensure that levels in the receiving water are acceptable. The figures below are achievable, if necessary, to meet water quality standards.

Table 3.6: Heavy metal benchmark emission values

Media	Substance	Activity	Achievable levels if required	Basis for the benchmark
To water	Mercury	Transferred from caustic	0.1 µg/l	Parity with other sectors
To Air	Heavy metals	Combustion/incineration	See appropriate guidance	

3.7 Nitrogen oxides

Other applicable standards and obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.)

Statutory Instrument 1989 No 317, Clean Air, The Air Quality Standards Regulations 1989 gives limit values in air for nitrogen dioxide.

Statutory Instrument 1997 No 3043, Environmental Protection, The Air Quality Regulations 1997 gives air quality objectives to be achieved by 2005 for nitrogen dioxide.

The UNECE Convention on Long-Range Transboundary Air Pollution Negotiations are now under way which could lead to a requirement further to reduce emissions of NOx.

Waste Incineration Directive (Draft) requires a NOx level of 200 mg/m3.

Benchmark emission values

Table 3.7: Nitrogen oxides benchmark emission values

Media	Activity	Benchmark value		Basis for the benchmark
		Mass release	Concentration	
To air	From combustion plant		See appropriate Guidance	Will require the use of good combustion chamber design and low NOx burners

3.8 Nutrients (phosphates and nitrates)

Other applicable standards and obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.)

Table 3.8: Nutrients:water quality objectives in England, Wales and Northern Ireland

Water quality objectives England, Wales and Northern Ireland	Nitrite (mg/l N)	Ammonia total (mg/l N, 90%ile)	Non-ionised Ammonia (total) (mg/l N, 95%ile)
Class 1		0.25	0.021
Class 2		0.6	0.021
Class 3		1.3	0.021
Class 4		2.5	-
Class 5		9.0	-
Designated freshwaters SI 1997/1331			
Salmonid imperative: guideline:	- 0.150	0.780 0.030	0.021 0.004
Cyprinid imperative: guideline:	- 0.460	0.780 0.160	0.021 0.004

Table 3.9: Nutrients:water quality objectives in Scotland

Water quality objectives Scotland	Nitrite (mg/l N)	Ammonia total (mg/l N, 90%ile)	Non-ionised ammonia (total) (mg/l N, 95%ile)
Class Excellent		<0.25	0.021
Class Good		<0.6	0.021
Class Fair		<1.3	0.021
Class Poor		<9	-
Class Seriously Polluted		>9	-
Designated freshwaters SI 1997/2471			
Salmonid imperative: guideline:	- 0.150	0.780 0.030	0.021 0.004
Cyprinid imperative: guideline:	- 0.460	0.780 0.160	0.021 0.004

Benchmark emission values

Nitrogen and phosphorus in the raw wastewater will arise from debris removed in the cleaning processes and cleaning agents may also give rise to these substances. The benchmarks are obviously important where a treated effluent is being discharged to a watercourse, where account must be taken of nitrate or phosphate vulnerability of the receiving environment.

It is also an important measure where the effluent is to be treated off-site (see **Section 2.2.5** on page 66) where the Operator has to assess the off-site treatment against what could be carried out on-site under BAT criteria.

3.9 Particulate and suspended solids

The term “particulate” for releases to air includes all particle sizes from submicro combustion fume to coarse dust from storage yards. “Suspended solids” refers to releases to water.

Other applicable standards and obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.)

Water

Table 3.10: Particulate and suspended solids in water

Designated freshwaters SI 1997/1331	Suspended solids annual average (mg/l)
Salmonid or cyprinid guideline:	25

Air

Statutory Instrument 1989 No 317, Clean Air, The Air Quality Standards Regulations 1989 gives limit values in air for suspended particulates.

Statutory Instrument 1997 No 3043, Environmental Protection, The Air Quality Regulations 1997 gives air quality objectives to be achieved by 2005 for PM10.

Benchmark emission values

Not available.

BAT requires that emissions are prevented or reduced where an assessment of the costs and benefits shows such action to be reasonable; however, the nature of the receiving water will influence the assessment of the benefits. However, particulate matter is a carrier for many other pollutants that adhere to it (whichever media it is released to) and this must also be taken into account. Reductions are more likely to be driven by the need to reduce BOD/COD.

Table 3.11: Particulate and suspended solids: benchmark emission values

Activity	Benchmark value	Basis for the benchmark
Fugitive from equipment, plant buildings, storage yards and materials handling (**Section 2.2.4** on page 64)	“No visible dust” criteria may normally be appropriate	Parity with other UK industrial sector benchmarks for fugitive or low-level, relatively benign, nuisance dusts
Point release from enclosed systems (**Section 2.2.4** on page 64)	50 mg/m^3	
Point release from combustion plant/ incineration	See appropriate Guidance	See appropriate Guidance Based on parity with other sectors

3.10 Sulphur dioxide

Other applicable standards and obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.)

Statutory Instrument 1989 No 317, Clean Air, The Air Quality Standards Regulations 1989 gives limit values in air for sulphur dioxide.

Statutory Instrument 1997 No 3043, Environmental Protection, The Air Quality Regulations 1997 gives air quality objectives to be achieved by 2005 for sulphur dioxide.

The UNECE Convention on Long-Range Transboundary Air Pollution Under this Convention, a requirement further to reduce SO2 emissions from all sources has been agreed. The second Sulphur Protocol (Oslo, 1994) obliges the UK to reduce SO2 emissions by 80% (based on 1980 levels) by 2010.

Benchmark emission values

Table 3.12: Sulphur dioxide: benchmark emission values

Media	Activity	Benchmark value		Basis for the benchmark
		Mass release	Concentration	
To air	From combustion plant		See appropriate Guidance	Would include low-sulphur fuels or control of sulphur emissions

3.11 Volatile organic compounds

The term “volatile organic compounds” includes all organic compounds released to air in the gas phase.

Other applicable standards and obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.)

The “Solvents Emissions Directive” The EC Directive on the limitation of emissions of VOCs due to the use of organic solvents in certain activities and installations is likely to be adopted soon.

“Reducing Emissions of VOCs and Levels of Ground Level Ozone: A UK Strategy” was published by the Department of the Environment in October 1993. It sets out how the Government expects to meet its obligations under the UNECE VOCs Protocol to reduce its emissions by 30% (based on 1988 levels) by 1999, including the reductions projected for the major industrial sectors. The Food and Drink sector was included in the “other miscellaneous industries” sector with no specific reduction targets stated.

The UNECE Convention on Long-Range Transboundary Air Pollution Negotiations are now under way which could lead to a requirement further to reduce emissions of VOCs.

Benchmark emission values

For emissions to water see BOD/COD

Table 3.13: Volatile organic compounds: benchmark emission values

Emission	Activity	Threshold	Benchmark value	Basis for the benchmark
Solvents (various)	Extraction	Emission > 5 t/yr	75 mg/m^3 (expressed as carbon)	Parity with other UK industrial sector benchmarks
VOCs and dioxins	Other combustion/incineration		See appropriate Guidance	

4 Impact

4.1 Impact assessment

The Operator should assess that the emissions resulting from the proposals for the activities/installation will provide a high level of protection for the environment as a whole, in particular having regard to EQS etc, revisiting the techniques in Section 2 as necessary. The use of **IPPC Environmental Assessments for BAT**, and the **IPPC Environmental Assessments for BAT software tool**, and the other tools on the Application CD, will lead the Applicant through the process.

The depth to which the impact assessment should go should be discussed with the Regulator. For some low risk sites the requirements may be reduced.

Indicative BAT requirements for impact assessment (Sheet 1 of 2) Provide an assessment of the potential significant environmental effects (including trans-boundary effects) of the foreseeable emissions.	
1	Provide a description, including maps as appropriate, of the receiving environment to identify the receptors of pollution. The extent of the area may cover the local, national and international (for example, transboundary effects) environment as appropriate.
2	Identify important receptors, which may include: areas of human population including noise or odour-sensitive areas, flora and fauna (that is, Habitat Directive sites, special areas of conservation, Sites of Special Scientific Interest (SSSI or in Northern Ireland ASSI) or other sensitive areas), soil, water, that is groundwater (water below the surface of the ground in the saturation zone and in direct contact with the ground and subsoil) and watercourses (for example, ditches, streams, brooks, rivers), air, including the upper atmosphere, landscape, material assets and the cultural heritage.
3	Identify the pathways by which the receptors will be exposed (where not self-evident).
4	Carry out an assessment of the potential impact of the total emissions from the activities on these receptors. **IPPC Environmental Assessments for BAT** provides a systematic method for doing this and will also identify where modelling needs to be carried out, to air or water, to improve the understanding of the dispersion of the emissions. The assessment will include comparison (see **IPPC: A Practical Guide**) with: • community EQS levels • other statutory obligations • non-statutory obligations • environmental action levels (EALs) and the other environmental and regulatory parameters defined in **IPPC Environmental Assessments for BAT**
5	In particular it will be necessary to demonstrate that an appropriate assessment of vent and chimney heights has been made to ensure that there is adequate dispersion of the minimised emission(s) to avoid exceeding local ground-level pollution thresholds and limit national and transboundary pollution impacts, based on the most sensitive receptor, be it human health, soil or terrestrial ecosystems.

Indicative BAT requirements for impact assessment (Sheet 2 of 2)
Provide an assessment of the potential significant environmental effects (including trans-boundary effects) of the foreseeable emissions.

6 Where appropriate, the Operator should also recognise the chimney or vent as an emergency emission point and understand the likely behaviour. Process upsets or equipment failure giving rise to abnormally high emission levels over short periods should be assessed. Even if the Applicant can demonstrate a very low probability of occurrence, the height of the chimney or vent should nevertheless be set to avoid any significant risk to health. The impact of fugitive emissions can also be assessed in many cases.

7 Consider whether the responses to Sections 2 and 3 and this assessment adequately demonstrate that the necessary measures have been taken against pollution, in particular by the application of BAT, and that no significant pollution will be caused. Where there is uncertainty about this, the measures in Section 2 should be revisited as appropriate to make further improvements.

8 Where the same pollutants are being emitted by more than one permitted activity on the installation, the Operator should assess the impact both with and without the neighbouring emissions.

4.2 Waste Management Licensing Regulations

Indicative BAT requirements for waste management licensing regulations
Explain how the information provided in other parts of the application also demonstrates that the requirements of the relevant objectives of the Waste Management Licensing Regulations 1994 have been addressed, or provide additional information in this respect.

1 In relation to activities involving the disposal or recovery of waste, the Regulators are required to exercise their functions for the purpose of achieving the relevant objectives as set out in Schedule 4 of the Waste Management Licensing Regulations 1994. (For the equivalent Regulations in Scotland and Northern Ireland, see **Appendix 2**.)

2 The relevant objectives, contained in paragraph 4, Schedule 4 of the Waste Management Licensing Regulations 1994 (SI 1994/1056 as amended) are extensive, but will only require attention for activities that involve the recovery or disposal of waste. Paragraph 4 (1) is as follows:

- ensuring the waste is recovered or disposed of without endangering human health and without using process or methods which could harm the environment and in particular without:
  - risk to water, air, soil, plants or animals or
  - causing nuisance through noise or odours or
  - adversely affecting the countryside or places of special interest
- implementing, as far as material, any plan made under the plan-making provisions

3 The application of BAT is likely to already address risks to water, air, soil, plants or animals, odour nuisance and some aspects of effects on the countryside. It will, however, be necessary for the Operator briefly to consider each of these objectives individually and provide a comment on how they are being addressed by your proposals. It is also necessary to ensure that any places of special concern that could be affected, such as SSSIs, are identified and commented upon although, again, these may have been addressed in your assessment for BAT, in which case a cross-reference may suffice.

4 Operators should identify any development plans made by the local planning authority, including any waste local plan, and comment on the extent to which the proposals accord with the contents of any such plan (see **Section 2.6** on page 84).

4.3 The Habitats Regulations

Indicative BAT requirements for the habitats regulations
Provide an assessment of whether the installation is likely to have a significant effect on a European site in the UK and, if it is, provide an assessment of the implications of the installation for that site, for the purpose of the Conservation (Natural Habitats etc.) Regulations 1994 (SI 1994/2716)

1 An application for an IPPC Permit will be regarded as a new plan or project for the purposes of the Habitats Regulations (for the equivalent Regulations in Scotland and Northern Ireland see **Appendix 2**). Therefore, Operators should provide an initial assessment of whether the installation is likely to have a significant effect on any European site in the UK (either alone or in combination with other relevant plans or projects) and, if so, an initial assessment of the implications of the installation for any such site. The application of BAT is likely to have gone some way towards addressing the potential impact of the installation on European sites and putting into place techniques to avoid any significant effects. The Operator should provide a description of how the BAT assessment has specifically taken these matters into account, bearing in mind the conservation objectives of any such site.

2 European sites are defined in Regulation 10 of the Habitats Regulations to include Special Areas of Conservation (SACs); sites of community importance (sites that have been selected as candidate SACs by member states and adopted by the European Commission, but which are not yet formally classified); and Special Protection Areas (SPAs). It is also Government policy (set out in PPG 9 on nature conservation) that potential SPAs and candidate SACs should be considered to be European sites for the purposes of Regulation 10.

3 Information on the location of European sites and their conservation objectives is available from:

- English Nature (01733 455000), **www.english-nature.org.uk**
- Countryside Council for Wales (01248 385620), **www.ccw.gov.uk**
- Scottish Natural Heritage (0131 447 4784), **www.snh.org.uk**
- Joint Nature Conservation Committee (01733 866852), **www.jncc.gov.uk**
- Environment and Heritage Service, Northern Ireland (02890254754), **www.ehsni.gov.uk**

4 The Regulator will need to consider the Operator's initial assessment. If it concludes that the installation is likely to have a significant effect on a European site, then the Regulator will need to carry out an “appropriate assessment” of the implications of the installation in view of that site's conservation objectives. The Regulations impose a duty on the Regulator to carry out these assessments, so it cannot rely on the Operator's initial assessments. Therefore the Regulator must be provided with any relevant information upon which the Operator’s assessment is based.

5 Note that in many cases the impact of the Habitats Regulations will have been considered at the planning application stage, in which case the Regulator should be advised of the details.

References

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

Ref 1 *The Pollution Prevention and Control Act (1999)* (**www.hmso.gov.uk**).

Ref 2 *The Pollution Prevention and Control Regulations* (SI 2000 No. 1973) (**www.hmso.gov.uk**).

Ref 3 *IPPC: A Practical Guide* (for England and Wales) (or equivalents in Scotland and Northern Ireland) **www.defra.gov.uk/environment/ppc/ippcguide/index.htm**

Ref 4 Guidance for applicants

• *IPPC Part A(1) Installations: Guide for (Applicants England and Wales)* (includes Preparation of a Site Report in a Permit Application) (**EA website**).

• *PPC Part A Installations: Guide for Applicants (Scotland)* (Guidance for SEPA staff on land and groundwater considerations) **Guidance for SEPA staff on land and groundwater considerations**

Ref 5 Assessment methodologies:

• *E1 BPEO Assessment Methodology for IPC*

• *IPPC Environmental Assessments for BAT* H1

Ref 6 Waste minimisation support references

• *Environment Agency web site*. Waste minimisation information accessible via: **www.environment-agency.gov.uk/subjects/waste/131528**

• *Waste Minimisation – an environmental good practice guide for industry* (helps industry to minimise waste and achieve national environmental goals). Available free to companies who intend to undertake a waste reduction programme (tel: 0345 33 77 00)

• *Profiting from Pollution Prevention – 3Es methodology* (emissions, efficiency, economics). Video and A4 guide aimed at process industries. Available from Environment Agency, North East region (tel: 0113 244 0191, ask for Regional PIR)

• *Waste Minimisation Interactive Tools (WIMIT)*. Produced in association with Envirowise and the BOC Foundation (a software tool designed for small and medium businesses.). Available free from The Environmental Helpline (tel: 0800 585794)

• *ENVIROWISE*. A joint DTI/DEFRA programme, with over 200 separate case studies, good practice guides, leaflets, flyers, software tools and videos covering 12 industry sectors, packaging, solvents and the generic areas of waste minimisation and cleaner technology. ENVIROWISE is accessible via a FREE and confidential helpline (tel: 0800 585794) or via the web site **www.envirowise.gov.uk**

• *ENVIROWISE*, Increased Profit Through Improved Materials Additions: Management/Technical Guide, GG194/195

• *ENVIROWISE*, GG157, 1999

• *ENVIROWISE*, Cost-Effective Membrane Technologies for Minimising Wastes and Effluents, GG54

• *ENVIROWISE*, Turning Waste into Profit: A Good Practice Case Study at Joseph Heler, GC 150

• *Waste Management Information Bureau*. The UK's national referral centre for help on the full range of waste management issues. It produces a database called Waste Info, which is available for on-line searching and on CD-ROM. Short enquiries are free (tel: 01235 463162)

• *Waste Minimisation* – Institution of Chemical Engineers Training Package E07. Basic course which contains guide, video, slides, OHPs etc. (tel: 01788 578214)

• *BIO-WISE - profiting through industrial biotechnology.* A DTI programme providing free advice and information about how biotechnology can be used within manufacturing industry. Case studies, guides website and Helpline 0800 432100. **dti.gov.uk/biowise** (leather guide GG237 and case study 11

Ref 7 Water efficiency references:

• *Simple measures restrict water costs*, ENVIROWISE, GC22

• *Effluent costs eliminated by water treatment*,ENVIROWISE, GC24

• *Saving money through waste minimisation*: Reducing water use, ENVIROWISE, GG26

• *ENVIROWISE Helpline* 0800 585794

• *Optimum use of water for industry and agriculture dependent on direct abstraction: Best practice manual*. R&D technical report W157, Environment Agency (1998), WRc Dissemination Centre, Swindon (tel: 01793 865012)

• *Cost-effective Water Saving Devices and Practices* ENVIROWISE GG067

• *Water and Cost Savings from Improved Process Control* ENVIROWISE GC110

• *Tracking Water Use to Cut Costs* ENVIROWISE GG152

Ref 8 Main activities and abatement:

• Fellows, P.J, Food Processing Technology Principles and Practice, 2nd Edition, 2000, Woodhead Publishing, ISBN 1 85573 533 4

• Food Processing, November 2000

• ETBPP, Reducing the Cost of Cleaning in the Food and Drink Industry, GG154

Ref 9 Releases to air references:

• BREF on Waste Water and Waste Gas Treatment.

• A1 Guidance on effective flaring in the gas, petroleum etc. industries, 1993, ISBN 0-11-752916-8

• A2 Pollution abatement technology for the reduction of solvent vapour emissions, 1994, £5.00, 0-11-752925-7

• A3 Pollution abatement technology for particulate and trace gas removal, 1994, £5.00, 0-11-752983-4

• 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

Ref 10 Releases to water references

• BREF on Waste Water and Waste Gas Treatment

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

• *Pollution Prevention Guidance Note – Above-ground oil storage tanks*, PPG 2, Environment Agency, gives information on tanks and bunding which have general relevance beyond just oil (**EA website**)

• *Construction of bunds for oil storage tanks*, Mason, P. A, Amies, H. J, Sangarapillai, G. Rose, Construction Industry Research and Information Association (CIRIA), Report 163, 1997, CIRIA, 6 Storey's Gate, Westminster, London SW1P 3AU. Abbreviated versions are also available for masonry and concrete bunds (www.ciria.org.uk on-line purchase)

• *Policy and Practice for the Protection of Groundwater* (PPPG) (**EA website**)

• *Choosing Cost-effective Pollution Control* ENVIROWISE GG109

• *Cost-effective Separation Technologies for Minimising Wastes and Effluents* ENVIROWISE GG037

• *Cost-effective Membrane Technologies for Minimising: Wastes and Effluents* ENVIROWISE GG054

Ref 11 Waste management references

• *Investigation of the criteria for, and guidance on, the landspreading of industrial wastes* – final report to the DEFRA, the Environment Agency and MAFF, May 1998

Ref 12 Energy references

• *(Interim) Energy Efficiency Guidance,*(available as draft Horizontal Guidance Note IPPC H2) (**www.environment-agency.gov.uk)**

Ref 13 COMAH guides

• *A Guide to the Control of Major Accident Hazards Regulations 1999*, Health and Safety Executive (HSE) Books L111, 1999, ISBN 0 07176 1604 5

• *Preparing Safety Reports: Control of Major Accident Hazards Regulations 1999*, HSE Books HS(G)190, 1999

• *Emergency Planning for Major Accidents: Control of Major Accident Hazards Regulations 1999*, HSE Books HS(G)191, 1999

• *Guidance on the Environmental Risk Assessment Aspects of COMAH Safety Reports*, Environment Agency, 1999 (**EA website**)

• *Guidance on the Interpretation of Major Accidents to the Environment for the Purposes of the COMAH Regulations*, DEFRA, 1999, ISBN 753501 X, available from the Stationery Office

Ref 14 Monitoring Guidance

• *MCERTS approved equipment* link via **www.environment-agency.gov.uk/business/mcerts**

• *M1 Sampling facility requirements for the monitoring of particulates in gaseous releases to atmosphere*, March 1993, £5.00, ISBN 0-11-752777-7

• *M3 Standards for IPC Monitoring Part 1: Standards, organisations and the measurement infrastructure*, August 1995, £11.00, ISBN 0-11-753133-2

• *M4 Standards for IPC Monitoring Part 2: Standards in support of IPC Monitoring*, revised 1998

• *Direct Toxicity Assessment for Effluent Control* Technical Guidance (2000), UKWIR 00/TX/02/07

Ref 15 Noise references:

• *H3 Horizontal Guidance for Noise Part 1*Regulation and Permitting

• *H3 Horizontal Guidance for Noise Part 2* Assessment and Control

Ref 16 Closure references

• *Working at Construction and Demolition-sites* (PPG 6) (**EA website**)

Ref 17 Directives

• *Hazardous waste incineration Directive* (1994/67/EC)

• *Waste incineration Directive* (2000/76/EC)

• *Large Combustion Plant Directives* (1988/609/EEC)

• *Habitiats Directive* (92/43/EC)

Ref 18 Air Dispersion

• *Guidelines on Discharge Stack Heights for Polluting Emissions,* HMIP Technical Guidance Note (Dispersion) D1, 1993, ISBN 0-11-752794-7 **www.tso.co.uk/bookshop**; (or **www.environment-agency.gov.uk** for summary only)

Ref 19 Fire Fighting

• *BS 5908: Code of Practice for Fire Precautions in the Chemical and Allied Industries*

• *PPG 18 - Managing Fire-water and major spillages,* Environment Agency Pollution Prevention Guidance Note (see Ref 10)

Ref 20 Volatile Organic Compounds

• *The Categorisation of Volatile Organic Compounds,*1995 HMIP Research Report No DOE/HMIP/RR/95/009 (**www.environment-agency.gov.uk**)

Abbreviations

BAT	Best Available Techniques – see IPPC A Practical Guide or the Regulations for further definition
BAT Criteria	The criteria to be taken into account when assessing BAT, given in Schedule 2 of the PPC Regulations
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
NIEHS	Northern Ireland Environment and Heritage Service
SAC	Special Areas of Conservation
SECp	Specific Energy consumption
SEPA	Scottish Environment Protection Agency
SPA	Special Protection Area
TSS	Suspended solids
TOC	Total Organic Carbon
VOC	Volatile organic compounds

Appendix 1: Some common monitoring and sampling methods

Table 4.1: Measurement methods for common substances to water

Determinand	Method	Detection limit Uncertainty	Valid for range (mg/l)	Standard
Suspended solids	Filtration through glass fibre filters	1 mg/l 20%	10–40	ISO 11929:1997 EN872 Determination of suspended solids
COD	Oxidation with dichromate	12 mg/l 20%	50–400	ISO 6060: 1989 Water Quality – Determination of chemical oxygen demand
BOD5	Seeding with micro-organisms and measurement of oxygen content	2 mg/l 20%	5–30	ISO 5815: 1989 Water Quality – Determination of biological oxygen demand after 5 days, dilution and seeding method
AOX	Adsorption on activated carbon and combustion	20%	0.4–1.0	ISO 9562: 1998 EN1485 – Determination of adsorbable organically bound halogens.
Tot P				BS 6068: Section 2.28 1997 – Determination of phosphorus – ammonium molybdate spectrometric method
Tot N				BS 6068: Section 2.62 1998 – Determination of nitrogen Part 1 Method using oxidative digestion with peroxydisulphate
pH				SCA The measurement of electric conductivity and the determination of pH ISBN 0117514284
Turbidity				SCA Colour and turbidity of waters 1981 ISBN 0117519553
Flow rate	Mechanical ultrasonic or electromagnetic gauges			SCA Estimation of flow and load ISBN 011752364X
Temperature				
TOC				SCA The instrumental determination of total organic carbon and related determinants, 1995, ISBN 0117529796
Fatty acids				Determination of volatile fatty acids in sewage sludge, 1979, ISBN 0117514624
Metals				BS 6068: Section 2.60 1998 – Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy
Chlorine				BS6068: Section 2.27 1990 – Method for the determination of total chlorine: iodometric titration method
Chloroform Bromoform				BS 6068: Section 2.58 Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods
Dispersants Surfactants anionic cationic non-ionic				SCA Analysis of surfactants in waters, wastewaters and sludges, ISBN 01176058

Table 4.1: Measurement methods for common substances to water

Pentachloro-phenol				BS5666 Part 6 1983 – Wood preservative and treated timber quantitative analysis of wood preservatives containing pentachlo-rophenol
Formalde-hyde				SCA The determination of formaldehyde, other volatile aldehydes and alcohols in water
Phosphates and Nitrates				BS 6068: Section 2.53 1997 Determination of dissolved ions by liquid chromatography
Sulphites and sulphates				BS 6068: Section 2.53 1997 Determination of dissolved ions by liquid chromatography
Ammonia				BS 6068: Section 2.11 1987 – Method for the determination of ammonium: automated spectrometric method
Grease and oils	IR absorption	0.06 mg/kg		SCA The determination of hydrocarbon oils in waters by solvent extraction IR absorption and gravimetry ISBN 011751 7283

Table 4.2: Measurement methods for other substances to water

Substance	Typical QL in clear water Note 1 mg/l	Typical QL in dirty water Note 2 mg/l	Technique Note 3	Likely Source
Mercury	0.1	0.1	CVAF	7
Cadmium	0.6	0.6	ICPMS	7
HCH (inc Lindane)	0.05	0.2	GC-MS	6
DDT	0.05	0.2	GC-MS	6
Pentachlorophenol	1.0	1.0	GC-MS	1
Hexachloro-benzene	0.05	0.2	GC-MS	6
Hexachloro-butadiene	0.05	0.2	GC-MS	6
Aldrin	0.05	0.2	GC-MS	6
Dieldrin	0.05	0.2	GC-MS	6
Endrin	0.05	0.4	GC-MS	6
PCBs	0.05	0.2	GC-MS	6
Dichlorvos	0.05	0.2	GC-MS	6
1,2 Dichloroethane	5.0	5.0	GC-ECD	6
Trichlorobenzene	0.05	0.2	GC-MS	6
Atrazine	0.10	0.4	GC-MS	6
Simazine	0.10	0.4	GC-MS	6
Tributyl tin and Triphe-nyltin (as total organic tin)	0.04	0.04	GFAAS Note 5	6
Trifluralin	0.05	0.2	GC-MS	6
Fenitrothion	0.05	0.2	GC-MS	6
Azinphos-methyl	N/a	n/a	GC-MS	6
Malathion	0.05	0.2	GC-MS	6
Endosulphan	0.05	0.2	GC-MS	6

Notes:

1. River water or treated effluent (< 100 mg/l COD)

2. Abbreviations:

- GC-ECD: gas chromatography - electron capture detection
- ICPMS: inductively coupled plasma mass spectrometry
- CVAF: cold vapour atomic fluorescence
- GC-MS: gas chromatography mass spectrometry
- GFAAS: graphite furnace atomic absorption spectrophotometry

3. The "quantifiable level" (QL) represents, for organic substances, the point at which there should be a 95% confidence in the levels of accuracy and precision obtained and with an overall maximum error level of 50% (precision and bias). At levels of around one tenth of these, at the "ultimate limit of detection", it is normally possible to detect the presence or absence of determinands at the 95% confidence level, but not to put a numerical value on it. While the "ultimate limit of detection" may be applicable for detecting the likely presence or absence of prescribed substances, regulatory limits are not normally set at levels below the "quantifiable level".

For metals the above applies in principle but the figures given are based on the WRC NS30 (previously TL66) method.

Levels between the quantifiable levels and the ultimate limit of detection need to be treated with caution but can be useful when assessing the likely extent of the presence of prescribed substances.

4. Most laboratories have or are developing methodologies for quantifying tributyl and triphenyl tin expressible as the cation or the compound. A similar level of detection would be expected.

Table 4.3: Measurement methods for air emissions

Determinand	Method	Av'ging time Detection limit Uncertainty	Compliance criterion	Standard
Formaldehyde	Impingement In 2,4 dinitrophenyl-Hydrazine HPLC	1 hour 1 mg/m^3 30%	Average of 3 consecutive samples below specified limit	NIOSH
Ammonia	Ion chromatography	1 hour 0.5mg/m^3 25%		US EPA Method 26
VOCs Speciated	Adsorption Thermal Desorption GCMS	1 hour 0.1 mg/m^3 30%		BS EN 1076:Workplace atmospheres. Pumped sorbent tubes for the determination of gases and vapours. Requirements and test methods.
Chloroform	Absorption on activated carbon solvent extraction. GC analysis	1 hour 1 mg/m^3 20%		MDHS 28 Chlorinated hydrocarbon solvent vapours in air (modified)
Oxides of Sulphur	UV fluoresence automatic analyser	1 hour 1 ppm 10%	95% of hourly averages over a year below specified limit	ISO 7935 (BS6069 Section 4.4) Stationary source emissions-determination of mass concentrations of sulphur dioxide CEN Standard in preparation
	Wet sampling train Ion chromatography	1 hour 1 mg/m^3 25%	Average of 3 consecutive samples below specified limit	ISO 7934 (BS6069 Section 4.1) Method for the determination of the mass concentration of sulphur dioxide-hydrogen peroxide/barium perchlorate method

Measurement uncertainty is defined as total expanded uncertainty at 95% confidence interval calculated in accordance with the Guide to the Expression of Uncertainty in Measurement, ISBN 92-67-10188-9, 1st Ed., Geneva, Switzerland, ISO 1993.

See also **Monitoring Guidance**.

Appendix 2: Equivalent legislation in Scotland & Northern Ireland

The legislation referred to in the text is that for England. The following are the equivalents for Scotland, Wales and Northern Ireland.

Table 4.4: Equivalent legislation

England	Wales	Scotland	Northern Ireland
PPC Regulations (England and Wales) 2000, SI 2000 No.273 (as amended)	As England	PPC (Scotland) Regulations 2000, SSI 2000 No.323 (as amended)	PPC (NI) Regulations 2003, SR 2003 No.323
SI:1994 1056: Waste Management Licensing Regulations	As England	As England	To be prepared
The Water Resources Act 1991	As England	COPA 1974 (S30A-30E equiv to Part III WRA91): Natural Heritage (Scotland) Act 1991 (Part II equiv to Part I WRA91)	The Water (NI) Order 1999
SI 1989 No.317: Clean Air, The Air Quality Standards Regulations 1989 SI 1995 No. 3146: The Air Quality Standards (Amendments) Regulations 1995 SI 2002 No. 3043 The Air Quality (England) (Amendment) Regulations 2002	As England SI 2002 No. 3182 (W.298) The Air Quality (Amendment) (Wales) Regulations 2002	As England SSI 2002 No. 297 The Air Quality (Scotland) Amendment Regulations 2002	SR 1990 No.145: The Air Quality Standards Regulations (Northern Ireland) 1990 SR1996 No.23: The Air Quality Standards (Amendments) Regulations (Northern Ireland) 1996
SI 2000 No.928: The Air Quality (England) Regulations 2000 SI 2002 No. 3117 The Air Quality Limit Values (Amendment) Regulations 2002	SI 2000 No.1940 (W.138): The Air Quality (Wales) Regulations 2000 SI 2002 No. 3183 (W.299) The Air Quality Limit Values (Wales) Regulations 2002	SSI 2000/97: The Air Quality (Scotland) Regulations SSI 2002 No. 566 The Air Quality Limit Values (Scotland) Amendment Regulations 2002	No NI equivalent
SI 2001 No.2315: The Air Quality Limit Values Regulations 2001	SI 2001 No.2683 (W.224): The Air Quality Limit Values (Wales) Regulations 2001	SSI 2001 No.224: The Air Quality Limit Values (Scotland) Regulations 2001	SI 2002 No.94: The Air Quality Limit Values (Northern Ireland) Regulations 2002
SI 1989 No 2286 and 1998 No 389: The Surface Water (Dangerous Substances Classification) Regulations. (Values for List II substances are contained in SI 1997/2560 and SI 1998/389)	As England	SI 1990/126: Surface Water (Dangerous Substances) (Classification) (Scotland) Regulations	Surface Waters (Dangerous Substances) (Classification) Regulations 1998. Statutory Rules of Northern Ireland 1998 No 397
SI 1991 No.1597: Bathing Waters (Classification) Regulations 1991	As England	SI 1991 No.1609: Bathing Waters (Classification) (Scotland) Regulations 1991	The Quality of Bathing Water Regulations (NI) 1993

Table 4.4: Equivalent legislation

England	Wales	Scotland	Northern Ireland
SI 1997 No.1331: The Surface Waters (Fishlife) (Classification) Regulations 1997	As England	SI 1997 No.2471 (S.163): The Surface Waters (Fishlife) (Classification) (Scotland) Regulations 1997	The Surface Water (Fishlife) (Classification) Regulations (NI) 1997
SI 1997 No.1332: The Surface Waters (Shellfish) (Classification) Regulations 1997	As England	SI 1997 No.2470 (S.162): The Surface Waters (Shellfish) (Classification) (Scotland) Regulations 1997	The Surface Water (Shellfish) (Classification) Regulations (NI) 1997
SI 1994 No.2716: The Conservation (Natural Habitats, etc) Regulations	As England	As England	Conservation (Natural Habitats etc) Regulations (Northern Ireland) 1995
SI 1999 No.743: Control of Major Accident Hazards Regulations (COMAH) 1999	As England	As England	SR 2000 No.93: Control of Major Accident Hazards Regulations (Northern Ireland) 2000
SI 1998 No.2746: The Groundwater Regulations 1998	As England	As England	SR 1998 No.401. The Groundwater Regulations (Northern IrelandI) 1998

Appendix 3: Groundwater Regulations 1998 Sechdule of listed substances and recommendations for List I (DEFRA)

List I

1.-(1) Subject to the sub paragraph below, a substance is in List I if it belongs to one of the following families or groups of substances:

(a) organohalogen compounds and substances that may form such compounds in the aquatic environment

(b) organotin compounds

(c) substances that possess carcinogenic, mutagenic or teratogenic properties in or via the aquatic environment (including substances that have those properties that would otherwise be in List II)

(d) mercury and its compounds

(e) cadmium and its compounds

(f) mineral oils and hydrocarbons

(g) cyanides.

1.-(2) A substance is not in List I if it has been determined by the Regulator to be inappropriate to List I on the basis of a low risk of toxicity, persistence and bioaccumulation.

List II

2.-(1) A substance is in List II if it could have a harmful effect on groundwater and it belongs to one of these families or groups of substances:

(a) the following metalloids and metals and their compounds:

zinc	tin	copper
barium	nickel	beryllium
chromium	boron	lead
uranium	selenium	vanadium
arsenic	cobalt	antimony
thallium	molybdenum	tellurium
titanium	silver	

(b) biocides and their derivatives not appearing in List I

(c) substances that have a harmful effect on the taste or odour of groundwater, and compounds liable to cause the formation of such substances in such water and to render it unfit for human consumption

(d) toxic or persistent organic compounds of silicon, and substances that may cause the formation of such compounds in water, excluding those which are biologically harmless or are rapidly converted in water into harmless substances

(e) inorganic compounds of phosphorus and elemental phosphorus

(f) fluorides

(g) ammonia and nitrates.

2.-(2) A substance is also in List 2 if:

(a) it belongs to one of the families or groups of substances set out in paragraph 1(1) above

(b) it has been determined by the Regulator to be inappropriate to List I under paragraph 1(2); and

(c) it has been determined by the Regulator to be in inappropriate to List II having regard to toxicity, persistence and bioaccumulation.

3.-(1) The Secretary of State or Scottish Ministers may review any decision of the Regulator in relation to the exercise of its powers under the paragraphs above.

3.-(2) The Secretary of State or Scottish Minister shall notify the Regulator of his decision following a review under List 1 sub paragraph 1 above and it shall be the duty of the Regulator to give effect to that decision.

4.- The Regulator shall from time to time publish a summary of the effect of its determinations under this Schedule in such manner as it considers appropriate and shall make copies of any such summary available to the public free of charge.

List of substances recommended to be confirmed as List I

- as recommended by the Joint Agency Groundwater Directive Advisory Group.

Aldrin	Diuron
Atrazine	Endosulfan
Azinphos-ethyl	Fenitrothion
Bromoxynil (as Bromoxynil-phenol)	Fenthion
Bromoxynil octanoate	Heptachlor
Cadmium	Hexachlorobenzene
2-Chloroaniline	Hexachlorobutadiene (HCBD)
Chlorobenzene	Hexachlorocyclohexane
Chlordane	Hexachloroethane
Chloro-2,4-dinitrobenzene	Hexachloronorbornadiene
Chlorfenvinphos	Hexaconazole
4-Chloro-3-methylphenol	3-Iodo-2-proponyl n-butyl carbamate (IPBC)
Chloro-2-nitrobenzene	Linuron
Chloro-3-nitrobenzene	Malathion
Chloro-4-nitrobenzene	Mercury
2-Chlorophenol	Mevinphos
Chlorothalonil	Oxydemeton-methyl
2-Chlorotoluene	Parathion
a-Chlorotoluene	Parathion-methyl
Chlorpyrifos	Pentachlorobenzene
Coumaphos	Pentachloroethane
Cypermethrin	Pentachlorophenol (PCP)
DDT	Permethrin
Demeton	Propanil
Diazinon	Simazine
Dibutyl bis(oxylauroyl)tin	Tetrabutyltin
Dichlofluanid	1,2,4,5-Tetrachlorobenzene

Dichloroaniline

1,2-Dichlorobenzene

1,3-Dichlorobenzene

1,4-Dichlorobenzene

Dichloronitrobenzene (all isomers)

2,4-Dichlorophenol

1,3-Dichloropropene

Dichlorprop

Dichlorvos

Dicofol

Dieldrin

Dimethoate

Tetrachloroethylene

Triazophos

Tributyl tin oxide (TBTO)

Tributyl-phosphate

Trichlorfon

1,2,4-Trichlorobenzene

Trichloroethylene

Trichlorophenol (all isomers)

Trifluralin

Triphenyl tin oxide (TPTO)

Triphenyl-phosphate