Technical Guidance Note

IPPC S6.10

Integrated Pollution Prevention and Control (IPPC)

General Guidance for the Food and Drink Sector

ENVIRONMENT AND HERITAGE SERVICE

SEPA Scottish Environment Protection Agency

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Executive Summary

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

What is IPPC

Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. It involves determining the appropriate controls 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 Agencies intend to implement IPPC to:

- protect the environment as a whole;
- promote the use of “clean technology” to minimise waste at source ;
- encourage innovation, by leaving significant responsibility for developing satisfactory solutions to environmental issues with industrial operators; and
- provide a “one-stop shop” for administering applications for permits to operate.

Once a permit has been issued, other parts of IPPC come into play. These include compliance monitoring, periodic permit reviews, variation of permit conditions and transfers of permits between operators. IPPC also provides for the restoration of industrial sites when the permitted activities cease to operate.

This Guidance and the BREF

The food and drink industry is due to be brought into IPPC (PPC Regulations 2000 No. 1973 Schedule 3) from June 2004 onwards. This document is interim UK Guidance for delivering the PPC Regulations in the 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 which operators making an application should follow to ensure that all aspects of the PPC Regulations (see Appendix 2 for equivalent legislation in Scotland and Northern Ireland) and other relevant Regulations have been addressed (see Section 1.2) and it should thereby assist the operator to make a satisfactory application;
- minimise the effort by both operator and regulator in the permitting of an installation by use of clear indicative standards and the use of material from previous applications, and from accredited Environmental Management Systems (EMSs);
- improve the consistency of applications by ensuring that all relevant issues are addressed;
- increase the transparency of the permitting process by having a structure in which the operators response to each issue, and any departures from the standards, can be seen clearly;
- improve consistency of regulation across installations and sectors by facilitating the comparison of applications;
- provide a description of the activities to assist the reader to understand the context of the requirements;
- provide a summary of the BAT techniques for pollution control and UK experience which are relevant in the UK context expressed, where possible, as clear indicative standards and which need to be addressed by applicants;
- provide an arrangement of information which allows the reader to find, quickly all of the guidance associated with:
    - a subject (e.g. accidents, energy or noise) (Sections 2.1 and 2.5 - 2.11);
    - the technical areas (e.g. cleaning or effluent management) (Sections 2.3 - 2.4);
    - particular emissions (e.g. COD) (Section 3).

Additionally, to assist operators in making applications, separate technical guidance is available on a range of topics such as waste minimisation, monitoring, calculating stack heights etc. The majority of this guidance is available free through the Environment Agency, SEPA or EPA (Ireland) web sites (see References).

By June 2004, the Agency anticipates having more specific guidance for particular sectors of the industry based on the BREF. In the meantime, the operators of new and substantially varied activities, who must seek permits before that date, are invited to use this guidance to help them make a satisfactory application.

CONTENTS

TABLE OF FIGURES

1 INTRODUCTION

1.1 Understanding IPPC and BAT

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 realising environmental benefits and costs incurred by Operators.

IPPC operates under the Pollution Prevention and Control (England and Wales) Regulations, (see Ref. 2 and Appendix 2). These Regulations have been made under the Pollution Prevention and Control (PPC) Act 1999 (Ref. 1) 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, Transport and the Regions (DETR) document *IPPC: A Practical Guide,* (see Ref. 3).

Installation based, NOT national emission limits

The "BAT" approach of IPPC is different from regulatory approaches based on fixed national emission limits (except where General Binding Rules (GBRs) have been issued by the Secretary of State). The legal instrument which ultimately defines BAT is the permit and this can only be issued at the installation level. The role of national guidance (such as this) for each sector is to express indicative standards. Where these <u>are</u> laid out, they should be applied unless there is strong justification for another course of action. This version of the document may not contain the entire range of relevant standards and where this is the case the operator must justify, using BAT criteria, why the techniques being proposed in the application could be considered to be BAT. Justification for these techniques and any departures from stated standards, in either direction, can be made taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. Notwithstanding this, if there are any applicable mandatory EU emission limits, they must be met first, although BAT may go further than them.

BAT and EQSs

The "BAT" approach is also different from, but complementary to, 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 process considers what can be reasonably achieved within the installation first (this is covered by Sections 2 and 3 of this Guidance) and only then checks to ensure that the local environmental conditions are secure, (Section 4 of this Guidance and Ref. 5). The BAT approach is, in this respect, a more precautionary one, which may go beyond the requirements of Environmental Quality Standards.

Conversely, it is feasible that the application of what is BAT may lead to a situation in which an EQS is still threatened. The Regulations therefore allow for expenditure beyond BAT where necessary. However, 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* (see Ref. 3). General information relevant to this sector and specific requirements for each substance are given 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 leaves flexibility to member states in its application. This UK Guidance Note lays down the interim (in advance of the BREF) indicative standards and expectations in the UK. At this national level, techniques which are considered to be BAT should, first of all, represent an appropriate balance of costs and benefits for a typical, well-performing installation in that sector. Secondly, the techniques should normally be affordable without making the sector as a whole uncompetitive either on a European basis or worldwide.

When assessing the applicability of the sectoral, indicative BAT standards at the installation level departures may be justified in either direction as described above. The most appropriate technique

Assessing BAT at the installation level

may depend upon 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 to establish the best option. Individual company profitability is **not** considered.

In summary, departures may be justified on the grounds of the technical characteristics of the installation concerned, its geographical location and the local environmental conditions but not on grounds of individual company profitability. Further information on this can be found in the Guide for Applicants, (see Refs. 3 and 4).

While BAT cannot be limited by individual company profitability, company finance may be taken into account in the following limited circumstances:

- where the BAT cost/benefit balance of an improvement only becomes favourable when the relevant item of plant is due for renewal/renovation anyway (e.g. BAT for drying may be to change to a different design when a dryer comes up for replacement). In effect, these are cases where BAT for the sector can be expressed in terms of local investment cycles.
- where a number of expensive improvements are needed, a phasing programme may be appropriate as long as it is not so extended that it could be seen to be rewarding a poor performing installation, (see Ref. 5 for more details).

Innovation

The Regulators encourage the development and introduction of new and innovative techniques which meet the BAT criteria and are looking for continuous improvement in the overall environmental performance of the process as a part of progressive sustainable development. This Note describes the appropriate indicative standards at the time of writing. However, operators should keep up to date with the best available techniques relevant to the activity and this Note may not be cited in an attempt to delay the introduction of improved, available techniques. The technical characteristics of a particular installation may allow for opportunities not foreseen in the Guidance; as BAT is ultimately determined at the installation level (except in the case of 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 activities. For new installations the indicative requirements should normally be in place before the commencement of operations. In some cases, such as where the requirement is for an audit of ongoing operations this is not feasible and indicative upgrading timescales are given for such cases.

Existing installations - standards

For an existing activity, a less strict proposal (or an extended timescale) may, for example, be acceptable where the activity already operates to a standard that is very close to an indicative requirement (see Section 2 for further guidance)

Existing installations - timescales

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

- 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 and monitoring equipment;
- the larger, usually more capital intensive improvements
- longer term studies required for control, environmental impacts etc.

All improvements should be carried out at the earliest opportunity and to a programme approved by the Regulator.

Specific improvements should be carried out within the timescales given below and the whole programme of any other items should be completed <u>at the latest</u> within 3 years of the issue of the permit. Any longer timescales will need to be justified by the Operator in accordance with the principles above.

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 2.2.2	31 August 2005 or 1 year from the issue of the permit	31 March 2006 or 1 year from the issue of the permit
A review of water use (water efficiency audit) in accordance with section 2.2.3	31 August 2005 or 1 year from the issue of the permit	31 March 2006 or 1 year from the issue of the permit

The Applicant should include a proposed timetable covering all improvements.

1.2 Making an Application

Complete the separate APPLICATION FORM.

The Application Form contains a number of questions about your ***techniques****,* ***emissions*** *and* ***impact on the environment****. The sections in this Technical Guidance note are numbered to match the application form and describe in detail how to answer the questions.*

The *Guide for Applicants* (see Ref. 3) will help filling in the form.

In SECTION 2, describe your proposals and justify that the TECHNIQUES employed are BAT by addressing the issues raised and the indicative standards in the outlined BAT boxes.

Departures may be justified as described in Section 1.1.

Indicative requirements (standards, benchmarks, improvement timescales etc.) are what the Agency would expect for the majority of installations. If they apply to you, simply confirm compliance. There may, however, be good site-specific reasons for departure. You should justify any departures. See Section 1.1.

Assess further options

In SECTION 3, identify the EMISSION LEVELS that will result from the techniques described in Section 2 and compare with Benchmarks (given in Section 3).

If the comparison is unsatisfactory (taking any site-specific matters into account) revisit the measures in Section 2 as necessary.

Justifications may vary from a simple statement to a full cost benefit analysis *(Note 1)*. **Where the costs and the cross-media benefits of different options need to be assessed the "Assessment of BAT from Several Options" part of Ref. 5 will help you to do this.**

In SECTION 4, assess the ENVIRONMENTAL IMPACT and confirm acceptability

Assess that these overall emissions resulting from your view of BAT for the activities or installation will provide a high level of protection for the environment as a whole. The "Assessing Impact of the Installation" part of Ref. 5 will help you to do this.

If the impact is not acceptable, it will be necessary to consider further options, revisiting the techniques in Section 2.

Note 1 The amount of detail needed to support the application should be sufficient to support the applicant's contention that either the conditions of the guidance have been met or an alternative measure has been justified. The level of detail should be commensurate with the scale of the operation and its ability to cause pollution. An applicant is not required to supply detail that could not reasonably be expected to contribute to a decision to issue a permit.

Note 2 **For existing IPC or Waste Management permit holders**, your response to each point in Sections 2, 3 or 4 may rely heavily on your previous application. The Agency does not wish you to duplicate information as long as the previous information adequately addresses the issues. However, the more the information can be reorganised to demonstrate that all the issues have been adequate addressed the better. You will need to send us copies of any information referred to.

Note 3 The contents of the outlined BAT boxes in Sections 2, 3 and 4, and additional blank tables etc., are available electronically on the Agency's Website, for the assistance of applicants.

1.3 Installations Covered

This Note covers installations described in Part A(1) of Section 6.8 of Schedule 1 to the PPC Regulations (see Ref. 2) as follows:

(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 includes the main activities as stated above and associated activities which have a technical connection with the main activities and which may have an effect on emissions and pollution. They include, as appropriate:

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

However, the impact of the activities on the environment may be wider than just the on-site activities. The Note, and the Regulations, cover issues downstream of the installation such as the final disposal of wastes and wastewaters.

Advice on the extent of the physical site which is contained within the installation, for example split sites, is given in *IPPC Part A(1) Installations: Guide for Applicants,* (see Ref. 4). Operators are advised to discuss this issue with the Agency prior to preparing their application.

Where associated activities are carried out in conjunction with the main activities and are not covered in this guidance note (for example combustion activities), reference should be made to:

- other relevant IPPC Guidance Notes; and,
- other relevant guidance notes issued under EPA 90 (e.g. Ref. 22).

Where appropriate, the Secretary of State's Guidance for Local Authority Air Pollution Control. (NB In Northern Ireland this guidance is produced by the Department of the Environment). For this sector, this would apply in particular to guidance on combustion plants.

However, the impact of the activities on the environment may be wider than just the on site activities. The Note, and the regulations, cover issues downstream of the installation such as the final disposal of wastes and wastewaters.

1.4 Review Periods

Permits can be reviewed or varied at any time. However, the PPC Regulations impose a requirement on regulators to review permits in certain specific circumstances such as where the pollution caused by the installation is of such significance that the existing emission limit values need to be revised or new limits set.

In addition, regulators are required to review the conditions of permits “periodically”. The Government, in its third consultation paper (England, Wales and Scotland) on the implementation of IPPC, stated that the new site-specific IPPC technical guidance notes would provide guidance on appropriate review periods for each sector, taking into consideration guidance on the relevant criteria to be provided by the Government. Examples of the likely relevant criteria for setting these review periods were stated as “the risk and level of environmental impacts associated with the sector” and “the cost to the regulators and regulated industry of undertaking the reviews”

The Regulators consider that at the present time, having regard to those criteria, it is in fact appropriate to set indicative minimum review periods which differ only between those sectors which have been subject to integrated permitting (i.e. IPC or Waste Management Licensing) and those which have not. It is therefore proposed that Permit conditions should normally be reviewed on the following basis:

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

This means that activities/installations not currently in IPC or Waste Management Licensing will be initially reviewed within four years and thereafter within six years.

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

1.5 Key Issues for this Sector

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 costs incurred by the operators and will not always result in cost savings for the operator.

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 sectors 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 reuse water (for example low-grade wash waters) or to recycle water from for example membrane systems (also see **Hygiene and Food Safety**).

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, SOx, NOx, etc. contributing in particular to global warming and acidification). The industry will enter into a Climate Change Levy Agreement with the Government. The applicability of techniques and standards for IPPC is explained in Section 2.6.

Emissions to air

It is an inherent factor within many food and drink processes that emissions of VOC 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, dependant on the activity, working patterns, product wastage and cleaning systems. Of these the most important 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 are 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 reuse 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

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 plant (Note 1)
Oxides of sulphur	-	-	-	-	-	-	-	-	-	-	-	A	-
Oxides of nitrogen & carbon	-	-	-	-	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
Dispersants & surfactants	-	-	-	-	-	-	-	-	W	-	-	-	-
Phosphates & nitrates	-	-	-	-	-			-	W	-	-	-	-
Refrigerants Ammonia, HCFC, Glycol	-	-	-		-	-	-	-	-	-	AW	W	W
Sludges	-	-	-		-			-	-	-	-	-	L
KEY	A – Release to Air, W – Release to Water, L – Release to Land												

Note 1 Most of the other releases water pass through the ETP. Included here are only those which arise as a direct result of the operation of the ETP.

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

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

For releases from combustion plant see the appropriate guidance (see Section 2.3.10).

1.7 Overview of the Activities in this Sector

Table 1-1 - Breakdown of the main activities by Standard Industry Classification (SIC) code

SIC Code	Sub-sector	Aggregated Sub-sector
15.11 15.11/1 15.11 /2 15.12	Production and preserving of meat Slaughtering of animals other than poultry and rabbits **(not covered by this guidance)** Animal by-product processing **(not covered by this guidance)** Production and preserving of poultry meat	Primary Meat Processing
15.13 15.13/1 15.13/2	Production of meat and poultry meat products Bacon and ham production Other meat and poultry meat processing	Secondary Meat Processing
15.20 15.20/1 15.20/2	Processing and preserving of fish and fish products Freezing of fish Other fish processing and preserving	Fish Processing
15.31 15.32 15.33	Processing and preserving of potatoes Manufacture of fruit and vegetable juice Processing and preserving of fruit and vegetables not elsewhere classified	Fruit & Vegetable Processing
15.41 15.42 15.43	Manufacture of crude oils and fats Manufacture of refined oils and fats Manufacture of margarine and similar edible fats	Oils & Fats
15.51 15.51/1 15.51/2 15.51 /3 15.52	Operation of dairies and cheese making Liquid milk and cream production Butter and cheese production Manufacture of other milk products Manufacture of ice cream	Milk Processing
15.61 15.61/1 15.61 /2 15.62	Manufacture of grain mill products Grain milling Manufacture of breakfast cereals and cereals-based foods Manufacture of starches and starch products	Cereal Processing
15.71	Manufacture of prepared feeds for farm animals	Animal Feed
15.72	Manufacture of prepared pet foods	Petfood
15.81 15.82	Manufacture of bread; manufacture of fresh pastry goods and cakes Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	Bread, Cakes and Biscuits
15.83	Manufacture of sugar	Sugar
15.84 15.84/1 15.84/2	Manufacture of cocoa; chocolate and sugar confectionery Manufacture of cocoa and chocolate confectionery Manufacture of sugar confectionery	Chocolate and confectionery
15.85	Manufacture of macaroni, noodles, couscous and similar farinaceous products	Pasta products
15.86 15.86/1 15.86/2	Processing of tea and coffee Tea processing. Production of coffee and coffee substitutes	Tea and coffee
15.87 15.88 15.89 15.89/1 15.89/2	Manufacture of condiments and seasonings Manufacture of homogenised food preparations and dietetic food Manufacture of other food products not elsewhere classified Manufacture of soup' Manufacture of other food products not elsewhere classified	Miscellaneous
15.91 15.92 15.93 15.93/1 15.93/2 15.94 15.94/1 15.94/2 15.95 15.96 15.97 15.98	Manufacture of distilled potable alcoholic beverages Production of ethyl alcohol from fermented materials Manufacture of wines Manufacture of wine of fresh grapes and grape juice Manufacture of wine based on concentrated grape must Manufacture of cider and other fruit wines Manufacture of cider and perry Manufacture of other fermented fruit beverages ` Manufacture of other non-distilled fermented beverages Manufacture of beer Manufacture of malt Production of mineral waters and soft drinks	Beverages and brewing

1.8 Economic Aspects

The food and drink industry 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 1-1 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 of 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 2.3.5.3), ohmic heating (see section 2.3.15) 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 redundant by a change in the production process.

The food and drink marketplace is characterised by:

- short time-to-market and competitiveness, where the time between product conception and delivering the product to the marketplace 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 and fads 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

This section summarises, in the outlined BAT boxes,

- what is required in the Application
- the indicative standards (i.e. what is BAT in most circumstances).

The indicative standards cover the techniques and measures which, in combination with those in the existing (IPC/Waste) guidance, have been identified as representing BAT in a general sense. They also cover the other requirements of the PPC Regulations and requirements 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 an IPPC Permit. For the sake of brevity these boxes simply use the term "BAT".

At the top of each BAT box is the question from the Application Form (derived from the Regulations) which is being addressed, (see Section 1.2).

In responding to the requirements the operator should keep the following general principles in mind:

- As a first principle there should be evidence in the application that full consideration has been given to the possibility of **PREVENTING** the release of harmful substances. This may, most commonly be by waste minimisation techniques see Section 2.2.1. The technology is available and there is also scope in many sectors to prevent or reduce releases of water see Sections 2.2.3 and 2.3.12. Similarly waste reuse or recovery can prevent waste emissions.
- Only where that is not practicable should the second principle be adopted of **REDUCING** emissions which may cause harm.
- All available options should be reviewed and it should be demonstrated that the selected combination of primary process and abatement equipment satisfies the Regulations.
- In general pollution control equipment should be kept running during start-up and shut-down for as long as is necessary to ensure compliance with release limits in permits.
- All plant and equipment should be subject to regular preventative maintenance programmes, in line with operational requirements, to ensure continued optimum performance. This should be detailed in response to Section 2.1 and elsewhere as appropriate.

2.1 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 environmental management systems (EMSs). An operator with such a system will find it easier to complete not only this section but also the technical/regulatory requirements in the following sections.

The Regulators recommend that the ISO 14001 standard is used as the basis for an environmental management system. Certification to this standard and/or registration under EMAS (EC Eco Management and Audit Scheme) (OJ L168, 10.7.93) are also strongly supported. Both certification and registration provide independent verification that the EMS conforms to an assessable standard. EMAS now incorporates ISO 14001 as the specification for the EMS element. For further details about ISO 14001 and EMAS contact British Standards Institute (BSI) and the Institute of Environmental Management and Assessment (IEMA) respectively.

The steps required in this and subsequent sections may help the operator to make good any shortfalls in their management system. An effective EMS will help the operator to maintain compliance with regulatory requirements and to manage other significant environmental impacts. While the requirements below are considered to be BAT for IPPC, they are the same techniques as required in a formal EMS and are also capable of delivering wider environmental benefits. However it is information on their applicability to IPPC which is primarily required in this Application.

Application Form Question 2.1

Provide details of your proposed management techniques.

BAT for management techniques

BREF Sections 4.4.1, 5.4.2, 6.4.2

With the Application the operator should:

1. Describe their management system in detail to demonstrate how it meets the ***"Requirements for an effective management system"*** below. The description should make clear who holds responsibility for each of the requirements and, where indicated in the second column, how the aspects are delivered and recorded for IPPC. Copies of all procedures are not needed, but examples may be included in your application.

   If you are certified to ISO 14001 or registered under EMAS (or both) you may provide a statement derived from certification records/assessments to support your application.

   Further specific management procedures are dealt with under the appropriate section on the remainder of the document. It is recommended that you understand all the requirements of the application before completing this section, as many management issues are dealt with in other sections.

2. The type of management system employed will depend upon the scale and complexity of the operations undertaken. The operator should demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements below and by justifying departures (as described in Section 1.2 and in the Guide to Applicants) or alternative measures.

Indicative BAT Requirements

The operator should have a management system in place for the activities which delivers the requirements given in column 1 below. The development of any aspects of the management system not already in place should be completed within the timescale given in Section 1.1.

Requirement for an effective management system	**How delivered for IPPC**
1. **Clear management structure and allocated responsibilities** for environmental performance, in particular meeting the aspects of the IPPC Permit	Describe in this section who has allocated responsibilities
2. **Identification, assessment and management of significant environmental impacts**	By responding to the requirements in Section 4.1 in the Application
3. **Compliance with legal and other requirements applicable to activities impacting on the environment**	Compliance with the permit satisfies this requirement

Cont.

BAT for management techniques (cont.)

4. **Establishing an environmental policy and setting objectives and targets** to prevent pollution, meet legal requirements and continually improve environmental performance	The Applicant should make proposals in response to each of Sections 2.2 to 2.12. These proposals may be incorporated within the Permit improvement programme
5. **Environmental improvement programmes to implement policy objectives and targets**	
6. **Establish operational controls to prevent and minimise significant environmental impacts**	By responding to the requirements in Sections 2.2 to 2.7, 2.11 and 2.12 in the Application
7. **Preventative maintenance programmes for relevant plant and equipment** – method of recording and reviews	Describe system here. List procedures in Section 2.3
8. **Emergency planning and accident prevention**	By responding to the requirements in Section 2.8 in the Application
9. **Monitoring and measuring performance** Identify key indicators of environmental performance and establish and maintain a programme to measure and monitor indicators to enable review and improvement of performance	Describe in this Section
10. **Monitoring and control systems**: • to ensure that the installation functions as intended; • to detect faults and unintended operations; • to detect slow changes in plant performance to trigger preventative maintenance	By responding to the requirements in Section 2.9 in the Application
11. **Training** Provision of adequate procedures and training for all relevant staff (including contractors and those purchasing equipment and materials), which should include: • a clear statement of the skills and competencies required for each job; • 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; • prevention of accidental emissions and action to be taken when accidental emissions occur; • implementation and maintenance of training records; Expertise required depends on the activities being carried out. However, both technical and managerial staff upon whom the installation's compliance depends need sufficient qualifications, training and experience for their roles. This may be assessed against any industry sector standards or codes of practice	To be described in this Section confirming that training for each of the areas covered by Sections 2.2 to 2.3 and 2.5 to 2.10 are covered
12. **Communication and reporting of incidents of actual or potential non-compliance and complaints** Actions taken in response, and about proposed changes to operations.	Describe in this Section
13. **Auditing** Regular, (preferably) independent, audits to check that all activities are being carried out in conformity with these requirements. All of these requirements should be audited at least once per year	Describe in this Section

Cont.

BAT for management techniques (cont.)

14. **Corrective action to analyse faults and prevent recurrence** Define responsibility and authority for handling and investigating non-conformance, taking action to mitigate any impacts caused and for initiating and completing corrective and preventive action Recording, investigating, taking corrective action and preventing recurrence, in response to environmental complaints and incidents	Describe in this Section how this is dealt with for each of Sections 2.2 to 2.3 and 2.5 to 2.10 as appropriate
15. **Reviewing and Reporting Environmental Performance** Senior management review environmental performance and ensure appropriate action taken where necessary to ensure that policy commitments are met and that policy remains relevant. Review progress of the Management Programmes at least annually.	Describe in this Section
Incorporate environmental issues in all other relevant aspects of the business, insofar as they are required by IPPC, in particular: • the control of process change on the installation; • design and review of new facilities, engineering and other capital projects; • capital approval; • the allocation of resources; • planning and scheduling; • incorporation of environmental aspects into normal operating procedures; • purchasing policy; • accounting for environmental costs against the process involved rather than as overheads	Describe in this Section
Report on environmental performance, based on the results of management reviews (annual or linked to the audit cycle), for:	This will become a permit requirement
• information required by the Regulator; and	Describe in this Section
• effectiveness of the management system against objectives and targets, and future planned improvements.	Describe in this Section
Report externally preferably via public environmental statement	

Selection of raw materials

2.2 Materials Inputs

This section covers the use of both **raw materials and water** and the techniques for both minimising their use and minimising their impact by selection or in process control.

The choice of fuels is covered under Section 2.7.3, Energy. Where the choice of fuel impacts upon emissions other than carbon the best option should be considered irrespective of whether a climate change levy agreement is in place.

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

Reduce
- **reduce** the use of chemicals and other materials

Substitute
- **substitute** less harmful materials or those which can be more readily abated and when abated lead to substances which in themselves are most readily dealt with.

Understand
- **understand** the fate of non-retained residues and their environmental impact, (Section 4).

2.2.1 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 food stuff 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 2.2.3. The other important class of raw materials are the ***auxiliary*** chemicals (see Table 2-1 below).

This section looks at the selection of raw materials used in this sector while Section 2.2.2 describes the techniques to minimise their use.

TABLE 2-1 - 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 Ethylene glycol and water, R404 and R22 (an HCFC).	Refrigerant Refrigerant Refrigerant	Very potent pollutant in event of spillage into watercourse or sewer. Leaks from refrigeration system will result in emissions to air. Has a high oxygen demand in event of spillage into watercourse or sewer. 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 2.2.2.3).
Caustic Acids (e.g. nitric, phosphoric acids) bleaches biocides	Cleaning and sanititisation 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.

Selection of raw materials

Application Form
Question 2.2 (part 1)

Identify the raw and auxiliary materials, other substances and water that you propose to use.

With the Application the operator should:

1. supply a list of the materials used, which have the potential for significant environmental impact, including:
   - the chemical composition of the materials where relevant;
   - the quantities used,
   - the fate of the material (i.e. approximate percentages to each media and to the product),
   - environmental impact where known (e.g. degradability, bioaccumulation potential, toxicity to relevant species).
   - any reasonably practicable alternative raw materials which may have a lower environmental impact including, but not be limited to, any alternatives described in BAT Requirement 5 below (the substitution principle).

   A suitable template is included in the electronic version of this document.

   Generic information about materials, and grouping information of those of a similar type, is normally adequate rather than listing every commercial alternative used. A common sense approach to the level of detail should be used; ensuring that any material could have a significant effect of the environment is included. Product data sheets should be available on-site.

2. justify (e.g. on the basis of impact on product quality), the continued use of any substance for which there is a less hazardous alternative and that the proposed raw material section is therefore BAT;

3. for existing activities, identify shortfalls in the above information, e.g. the environmental impact of certain substances, which the operator believes require longer term studies to establish.

Indicative BAT Requirements

BAT for selection of raw materials

1. The operator should complete any longer-term studies (Item 3 above) 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.

2. The operator should maintain a detailed inventory of raw materials used on-site.

3. The operator should have procedures for the regular review of new developments in raw materials and the implementation of any suitable ones which are less hazardous.

4. The operator should have quality assurance procedures for the control of the content of raw materials.

5. The following raw material substitutions should be applied where appropriate:

Raw material	Selection techniques
Organic solvents	*Super Critical Fluids:* The use of super critical carbon dioxide, for example, in the caffeine extraction process has eliminated the use of the more conventional hexane solvent.
Cleaning and sanititisation materials See section 2.3.10	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 2.3.2.4) and cleaning (see section 2.3.12.1)	Only “low mercury” NaOH should be used.
Fuels	See Section 2.7.3

For existing installations, the above techniques should be programmed for implementation within the timescale given in Section 1.1. Any substitutions should be carried out to a timescale to be agreed with the Regulator.

2.2.2 Waste minimisation (minimising the use of raw materials)

Principles

The prevention and minimisation of waste and emissions to the environment is a general principle of IPPC. Operators will be expected to consider the application of waste minimisation techniques so that, wherever practicable, all types of wastes and emissions are prevented or reduced to a minimum. The steps below will also help to ensure the prudent use of natural resources.

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 general term of waste minimisation and range from basic housekeeping techniques through statistical measurement techniques to the 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, through for example process control measures;
- 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.

See Ref. 6 for detailed information, guides and case studies on waste minimisation techniques.

Application Form Question 2.2 (part 2)

Identify the <u>raw and auxiliary materials, other substances</u> and water that you propose to use.

With the Application the operator should:

1. identify, from a knowledge of the plant, the main opportunities for waste minimisation and supply information on waste minimisation audits and exercises and the improvements made or planned.

Indicative BAT Requirements

BAT for waste minimisation

1. A regular waste minimisation audit should be carried out. Where one has not been carried out recently, an initial comprehensive audit should be carried out within the timescale given in Section 1.1 (noting that the Regulator is likely to require it to be programmed early within the list of work to be carried out by that date). New plants are also subject to this timescale as an audit cannot be carried out until the plant has been operating for some time. Further audits should be at least as frequent as the IPPC permit reviews. The audit should be carried out as follows:

   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:
   i) process mapping;
   ii) raw materials mass balance;
   iii) action plan.

   The use and fate of raw materials and other materials, including intermediates, by-products, solvents and other support materials, such as cleaning agents and fuels should be mapped onto a process flow diagram (see Ref. 6) using data from the raw materials inventory (see Section 2.2.1) 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.

   Using this information, opportunities for improved efficiency, changes in process and waste reduction should be generated and assessed and an action plan prepared for the implementation of waste minimisation projects.

The operator should implement any agreed techniques to a timescale agreed with the Regulator.

Use of raw materials

2.2.2.1 Process control

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.

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 of which are given below (refer to section 1.1 for an explanation of standards for new and existing installations).

Sub-Sectors	Percentage of Raw Material Loss.	Ratios
Liquid Milk	0.7-1% wastage	0.6:1 (water:final product)
Soft Drinks	1% wastage	1:1 (water:final product)
Brewing	4-6% wastage (post fermentation)	4:1 (water:final product)

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 2.3.2.4 Peeling.

It is important that process monitoring and control equipment selected is designed, installed 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:

Process monitoring techniques

Temperature measurement
Raw material waste and effluent generation can be reduced by controlling temperatures, for example, in storage vessels, processing vessels, transfer lines etc. The benefits will be reduced deterioration of materials, reduced out-of-specification products and less contamination (for example, solid or biological). Where possible temperature sensors should be used for dual purpose, for example monitoring both product and cleaning temperature.

Pressure Measurement
Pressure sensors are typically used for the indirect control of other parameters, for example flow or level. Pressure sensors in transfer lines control pump speed, pressure and flow velocity and are used to minimise waste from material damaged by shear friction forces. Differential pressure systems are used to monitor levels in storage or processing vessels. This minimises material loss from overflow or production downtime, due to lack of stock. They can also be used to monitor pressure drop across filters to control cleaning cycles and optimise operation.

Level Measurement
Level detecting sensors indicate whether or not a media is present at a specific point in a vessel, whereas a level-measurement sensor monitors all levels. These sensors 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. Options include:

- float valves (relatively cheap and effective, but can be easily damaged);
- mechanical indicators;
- capacitance level switches (they can also detect the interface between two different liquids and are commonly used in cleaning in place systems (CIP) to detect the water/product interface by accurately detecting the interface and minimising product loss to drain);
- vibrating level switches (typical applications include viscous sauces or mixtures, for example wet yeast in brewing);
- hydrostatic devices, (not suitable for applications where solids can build up on the diaphragm and for materials held constantly above 100 °C, as their accuracy is affected);
- ultrasonic sensors (surface foaming will affect accuracy);
- microwave devices (are similar to ultrasonic devices, but can be used in more extreme process conditions, as process temperatures, pressure or vacuum does not affect it);
- load cells (for vessels where intrusive monitoring measures may introduce a risk factor).

Flow Measurement
Flow measurement and control used in transfer lines will allow accurate addition of materials to processing vessels and minimise excessive use of materials and formation of out-of-specification products. In steam supplies it will help maintain correct operating temperature and minimise waste from under-heated or overheated materials and products. In cleaning systems it will control water use and optimise use and minimise effluent generation. Options include:

Use of raw materials

- variable area flow indicator or rotameter (only suitable for low flows and does not provide an associated control action);
- positive displacement meters;
- turbine meters (for low viscosity liquids, such as milk, beer and water, can be cleaned in situ and are relatively low cost);
- electromagnetic meters (suitable for use in hygienic applications);
- vortex shedding meters (suitable for measuring steam and low viscosity liquids and their maintenance requirements are low);
- differential pressure meters (suitable for measurement and control of relatively constant flow rates and are commonly used where high pressure and temperatures are required, for example to monitor boiler feed water);

Installation requirements for flow measurement

To reduce contamination, flow meters should be easy to clean and robust. In processes where fluids may solidify at low temperature, heat tracing may be required to ensure that it does not solidify in or around the equipment. To ensure that the meters read accurately, they must be positioned correctly, this will be dependent upon the type of meter and should be understood, for example rotameters should be mounted in vertical pipelines.

Analytical Measurement

To minimise wastage and to check the quality of materials the pH, conductivity and turbidity of a range of fluids should be commonly checked in-line. For example, pH sensors can be used to control additions of acid or alkali to reaction vessels and therefore minimise waste resulting from overdosing of raw materials and the production of out-of-specification product. Conductivity sensors can be used to monitor levels of dissolved salts prior to water re-use to minimise freshwater use and effluent volumes. Turbidity sensors can be used to monitor the quality of process water and CIP systems and will therefore minimise effluent from out-of-specification products/process water and optimise re-use of cleaning water respectively.

Process Controllers/Transmitters

Limit detectors or continuous transmitters are commonly used in the food and drink sector to receive data from measurement devices and/or to compare measured data to a set point and/or to transmit a signal to a control device, such as an actuated valve.

Flow Control

Globe and angle valves, needle control valves, butterfly valves and weir diaphragm valves are all used for the manual control of liquid flow rates. Examples include:

- the installation of constant flow valves, to control flow rate to water ring vacuum
- flow regulators being installed to fix process water flow rates for specific processes

Solenoid actuated valves - are low cost control techniques used throughout the food and drink sector, particularly for the control of process water.

Pumps can be controlled by monitoring devices, for example, to control material transfer. Some monitoring devices will indicate abnormal process conditions and will sound visual and audible alarms. Rapid response to these alarms can prevent product loss and prevent wastage from occurring.

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.

2.2.2.2 Recycling of auxiliary chemicals

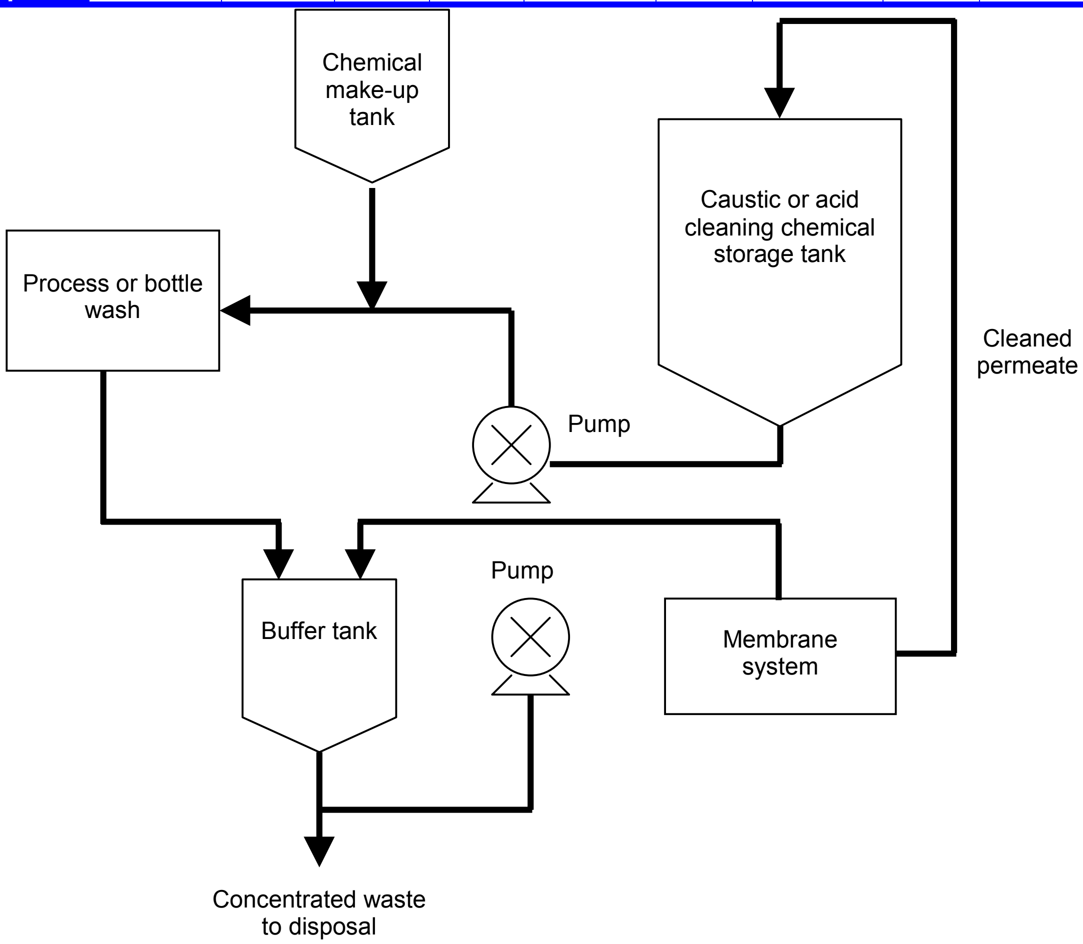
It was stated in Section 2.2.1 that a proportion of the chemicals used for cleaning purposes will end up in the final effluent, even if much reduced by treatment. This is not only a loss of a raw material, but means that more effort will be required to treat the effluent.

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). 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.

See Figure 2-1 for a schematic representation of a CIP recovery system.

Figure 2-1 - Cleaning-in-Place Chemical Recovery Membrane System



2.2.2.3 Packaging

Packaging includes a number of raw materials, for example 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:

- firstly, avoiding packaging;
- secondly, reducing packaging;
- thirdly, re-using packaging;
- fourthly, recycling packaging.

Packaging Design

The optimum packaging size should be used, which takes account of product size, shape, weight, distribution requirements and packaging material selected. 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 cardboard trays and shrink-wrap.

Water use

2.2.3 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 (flaming) raw material or waste;
- process water;
- cleaning of plant, process lines, equipment and process areas;
- washing of product containers;
- boiler make up.

Reasons for reducing water use

The use of a simple Mass Balance for water use will reveal where the greatest impact can be made in reducing water use. Reducing water use may be a valid environmental (or economic) aim in itself (perhaps because of local supply constraints).

However from the point of view of reducing polluting emissions, any water passing through an industrial process is degraded by the addition of pollutants, and there are distinct benefits to be gained from reducing the water used. In particular, reducing the water reaching the water treatment plant:

- reduces the emissions load to water (this is because the pollutant load is generally reduced by treatment to a specified discharge concentration level irrespective of the concentration arriving at the treatment plant. So if the treatment plant performs to 20mg/l of BOD, halving the number of litres will halve the effluent load);
- reduces the size of (a new) treatment plant thereby supporting the cost benefit BAT justification of better treatment;
- there are cost savings where water is purchased or disposed off to another party;
- there are also likely to be associated benefits within the process such as reduction of energy requirements for heating and pumping, and reduced dissolution of pollutants into the water leading to reduced sludge generation in the effluent treatment plant.
  - For example, a leak from a water supply pipeline or hose will not only represent a wastage of water, it will also be a revenue loss since that water will have been paid for and may have been pumped within the installation environment. In addition, if the leakage was of heated water, then there will be an additional cost from the energy consumed in heating the water. For every 10°C increase in water temperature, it costs typically, 16p/m^3 for water heated by gas or 47p/m^3 for water heated by electricity. Heating costs are in addition to the typical cost of 70p/m^3 for mains water or over £1.00/m^3 for softened water.

Application Form Question 2.2 (part 3)

Identify the uses of <u>water</u> within the installation and measures to minimise its use.

With the Application the operator should:

1. supply information on water consumption and comparison with any available benchmarks;
2. identify the water supplier and source;
3. supply a diagram of the water circuits with indicative flows and water mass balances for the activities (including the boiler plant and the de-ionisation and treatment operations), see also Section 2.6;
4. describe the current or proposed position with regard to the techniques below, any in the existing Sector Guidance or any others which are pertinent to the installation;
5. demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the Guide to Applicants) or alternative measures;
6. describe, in particular, any water audits already conducted and the improvements made or planned.

Cont.

Water use

BAT for water efficiency

Indicative BAT Requirements

1. A regular review of water use (water efficiency audit) should be carried out. Where one has not been carried out recently the initial review should be carried out within the timescale given in Section 1.1. New plants are also subject to this timescale as an audit cannot be carried out until the plant has been operating for some time. Further reviews should be at least as frequent as the IPPC permit reviews. It should be carried out as follows:
   - The operator should produce flow diagrams and water mass balances for the activities.
   - Water efficiency objectives should be established by comparison with national benchmarks (see Ref. 9). In justifying any departures from these (see Section 1.2), or where benchmarks are not available, the techniques described below should be taken into account. The constraints on reducing water use beyond a certain level should be identified by each operator, as this is usually installation-specific.
   - Water pinch techniques should be used in the more complex situations, to identify the opportunities for maximising reuse and minimising use of water (see ETBPP publications, Ref. 7).
   - Using this information, opportunities for reduction in water use should be generated and assessed and improvements proposed.
2. 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 which has a lower water quality requirement;
   - in particular, uncontaminated roof and surface water, which cannot be used, should be discharged separately.
3. Measures should be implemented to minimise contamination risk of process or surface water (see Section 2.3.14).
4. To identify the scope for substituting water from recycled sources, the water quality requirements associated with each use should be identified. Less contaminated water streams, e.g. cooling waters, should be kept separate where there is scope for reuse, possibly after some form of treatment.
5. Water used in cleaning and washing down (see section 2.3.10) should be minimised by:
   - vacuuming, scraping or mopping in preference to hosing down;
   - evaluating the scope for reusing wash water;
   - trigger controls on all hoses, hand lances and washing equipment.
   - recycling vehicle wash water where an automatic system is in place.
6. Water use should be minimised within the BAT criteria for the prevention or reduction of emissions and commensurate with the prudent use of water as a natural resource. The constraints (for example, hygiene issues) on reducing water use beyond a certain level should be identified by each operator, as this is usually installation-specific.
7. Water efficiency objectives should be established on a mass balance approach. The consumption of the activities should comply with relevant benchmarks. In justifying any departures from these the techniques described below should be taken into account. The constraints on reducing water use beyond a certain level should be identified by each operator, as this is usually installation-specific.

   The principles for reducing the use of fresh water are:
   - *m*onitoring 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,
     - washwaters.

Water use

BAT for water efficiency (cont.)

Cont.

8. **Reducing gross water use**
- Cleaning techniques (see section 2.3.10);
- Fresh water should only be used for:
  - process waters where water quality (e.g. pH, hardness, temperature) requirements of specific products (or equipment) is a factor. Tolerance to abnormal levels should be established so the lowest compatible quality can be used.
  - vacuum pump sealing (note, below, that this can be much reduced or even eliminated);
  - to make up for evaporative losses;
- Control should be simplified, if possible, to give one fresh water input point and one discharge point from the system.
- Once-through use of cooling water should be avoided in favour of closed loop systems (and where this is not possible the cooling water, which is generally uncontaminated, should be re-used).
- Measures to minimise contamination risk of process or surface water should be implemented (see Section 2.3.14).

9. **Pumps**

(Where used) water-sealed vacuum pumps 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);

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),

OR
- recycling the hot seal water for cleaning.

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 wastewaters.

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.

10. **Recycling principles**

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 2-2) showing a 4-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.

Cont.

Water use

BAT for water efficiency (cont.)

11. **Recycling of ETP effluent**

In many applications the best conventional effluent treatment produces a good water quality (see Section 2.2.2.1) 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.

12. **Tertiary treatment**

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

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.

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. 7)

Whist membrane techniques are applied in the Food and Drink sector (see section 2.3.9.4), 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 be not be an option (see Figure 2-10 - Dairy MBR).

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 reuse and can be used on unit processes which have been identified as significant contributors to the volume and or strength of the effluent.

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 sectors unit processes and the operator should assess the costs and benefits of providing tertiary treatment systems.

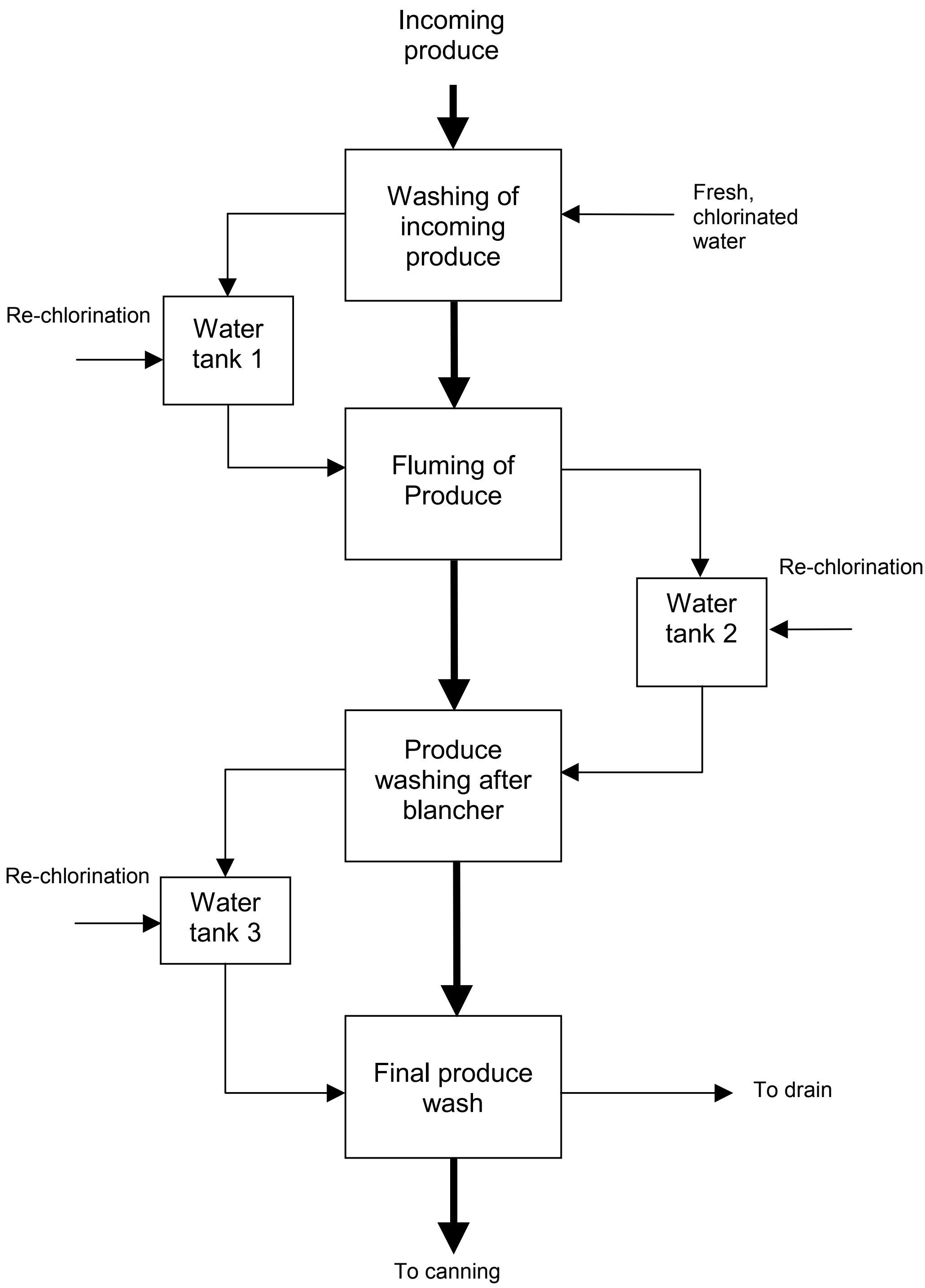


Figure 2-2 - Example of Four-Stage Counterflow System based on Pea Cannery

2.3 The Main Activities and Abatement

(includes **"directly associated activities"** in accordance with the PPC Regulations)

Application Form Question 2.3

Describe the proposed installation activities and the proposed 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, leak or malfunction)

With the Application the operator should:

1. provide adequate **process descriptions** of the activities and the abatement and control equipment for all of the activities such that the Regulator can understand the process in sufficient detail to assess the operators proposals and in particular to be able to assess opportunities for further improvements. This should include
   - process flow sheet diagrams (schematics);
   - diagrams of the main plant items where they have environmental relevance, e.g. Cleaning in Place systems;
   - details of any chemical reactions and their reaction kinetics/energy balance;
   - control system philosophy and how the control system incorporates environmental monitoring information;
   - mass and energy balance information;
   - venting and emergency relief provisions;
   - summary of current operating and maintenance procedures;
   - a description of how protection is provided during abnormal operating conditions such as start up, shut down and momentary stoppages;
   - additionally, for some applications it may be appropriate to supply piping and instrumentation diagrams for systems containing potentially polluting substances.

   If there is uncertainty, the degree of detail required should be established in pre-application discussions.

2. describe the current or proposed position for each unit process within the installation (section 2.3.1 to 2.3.10 covers a cross section of processes – or any others which are pertinent to the installation) and all of the listed requirements for subsections of 2.3.11 to 2.12,;

3. identify shortfalls in the above information which the operator believes require longer term studies to establish.

4. demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the Guide to Applicants) or alternative measures;

In assessing the integrated impacts of proposals and balancing the impacts of different techniques it should be noted that energy should be taken into account whether or not there is a Climate Change Levy Agreement in place (see Section 2.7.3).

Indicative BAT Requirements

See each subsection of this Section 2.3.

Materials handling

2.3.1 Materials handling, unpacking, storage

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

Summary of the activities

Solid materials are commonly delivered in bags on pallets. The same holds for liquid ingredients in containers. They are transported with forklift trucks, and stored in a store. 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, 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) are released 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.

Application Form Question 2.3 (cont.) | Materials Handling, Unpacking and Storage

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

BAT for materials handling

Indicative BAT Requirements

1. The main control issues are:
   - Cleaning techniques - see Section 2.3.10.
   - Air emissions from conveyors - see Section 2.5.
   - Accidents, for example overfilling of storage silos - see Section 2.8.
2. No further issues are identified.

Feedstock cleaning

2.3.2 Raw material preparation

2.3.2.1 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 to reach that (the surface of) the food is in a suitable condition for further processing. Contaminants can be soil, micro-organism, 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 2.3.10) 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 (8-16h) 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, which 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.

Application Form Question 2.3 (cont.) → Wet Feedstock Cleaning

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT 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 2.2.2).
2. The other main control issues are:
   - Effluent treatment - see Section 2.3.11.3.
   - Odour - see Section 2.3.15.
   - Accidents - see Section 2.8.
3. No further issues are identified.

Dry cleaning

2.3.2.2 Dry cleaning

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:

Summary of the activities

- 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.

Application Form Question 2.3 (cont.) — Dry Cleaning

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

BAT for dry cleaning

Indicative BAT Requirements

1. The main control issues are:
   - Emissions to air - see Section 2.3.11.
   - Noise - see Section 2.9.
2. No further issues are identified.

Sorting etc.

2.3.2.3 Sorting, screening, grading and trimming

Summary of the activities

Most raw materials contain contaminants and/or have components, which 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, which have to be heated or cooled. Large differences in size would cause over-processing 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, or 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 (blast 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.

Application Form Question 2.3 (cont.) → Sorting, Screening, Grading and Trimming

BAT for sorting etc.

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

1. The main control issues are:
   - Cleaning techniques - see Section 2.3.10.
   - Air emissions from screening - see Section 2.3.11.
2. No further issues are identified.

Peeling

2.3.2.4 *Peeling*

Summary of the activities

Many vegetables and some fruits require peeling, which can be a major source of BOD and TSS and represent 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 x4 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 batch-wise 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 sec.). 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 (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 of the fruits is caused.

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 to 2%) of sodium hydroxide. Due 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: VOC, 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 waste water stream.

Land: No direct impacts.

Waste: Food remnants removed by screens from waste water.

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

Accidents: Spillage of caustic.

Noise: Not applicable.

Peeling

BAT for peeling

Application Form Question 2.3 (cont.)

Peeling

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

1. The operator should show that for a specific feedstock where is more than one option for peeling techniques, the selection has taken into consideration:
    - Water and energy efficiency - see Sections 2.2.3 and 2.7.
    - Product loss
2. Other control issues are:
    - Emissions to air (odour and VOC)
    - Cleaning techniques - see Section 2.3.10.
    - Effluent treatment - see section 2.3.11.3.
3. No further issues are identified.

Grinding and milling

2.3.3 Size reduction

2.3.3.1 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:

- **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 again 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 direction. 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, for example 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.

BAT for grinding

Application Form Question 2.3 (cont.) | Grinding (Milling)

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

1. The main control issues are:
   - Product loss - see Section 2.2.2.
2. Other control issues are:
   - Emissions to air (dust and odour) - see Section 2.3.11.
   - Noise - see Section 2.9.
3. No further issues are identified.

Cutting etc.

2.3.3.2 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 in extreme cases will 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 in the pulping process also juice extraction is aimed.

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 like 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.

Application Form Question 2.3 (cont.) → Cutting, Slicing, Chopping, Mincing and Pulping

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT for cutting etc.

1. The main control issue is:
   - Cleaning techniques - see Section 2.3.10.
2. No further issues are identified.

Mixing etc.

2.3.3.3 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. There 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 and 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 it.

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 skimming 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 where volatile compounds are involved. Particulates (dust) are emitted in operations in that 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: Not applicable.

Noise: Not applicable.

Application Form Question 2.3 (cont.) — Mixing, Blending and Homogenisation

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT for mixing etc.

1. The main control issues are:
   - Cleaning techniques - see Section 2.3.10.
   - Emissions to air (dust and odour) - see Section 2.3.11.
2. No further issues are identified.

Forming etc.

2.3.4 Forming, moulding and extruding

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

Summary of the activities

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 is 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 built-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 the production process.

Energy: Extruders typically show relatively high power consumption.

Accidents: Not applicable.

Noise: Not applicable.

Application Form Question 2.3 (cont.) → Forming, Moulding and Extrusion

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

BAT for forming etc.

Indicative BAT Requirements

1. The main control issues are:
   - Cleaning techniques - see Section 2.3.10.
   - Emissions to air (dust and odour) - see Section 2.3.11.
2. No further issues are identified.

2.3.5 Heat processing using steam or water

2.3.5.1 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 minute 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 VOC, which may give rise to odour.

Water: Production of a low volume, high strength effluent. Typical characteristics of the waste water arising from the blanching operation are:

Volume waste water	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.

Application Form Question 2.3 (cont.)

Blanching

BAT for blanching

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

1. The main control issues are:
   - Water use (blanching water may be re-used in other parts of the process).
   - Cleaning techniques - see Section 2.3.10.
   - Emissions to air (dust and odour) - see Section 2.3.11.
   - Effluent treatment - see Section 2.3.11.3.
2. No further issues are identified.

Evaporation

2.3.5.2 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 °C 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 multistage shell and tubes, 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;
- preheating using the vapour to heat incoming feedstock or condensed vapour is used to raise steam in a boiler.

Periodical chemical cleanings are carried out in order to ensure any time an 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.

Evaporation

Application Form Question 2.3 (cont.)

Evaporation

BAT for evaporation

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

1. The main control issues are:
   - Cleaning techniques - see Section 2.3.10.
   - Emissions to air (dust and odour) - see Section 2.3.11.
   - Effluent treatment - see Section 2.3.11.3.
   - Energy efficiency - see Section 2.7.
2. No further issues are identified.

Pasteurisation

2.3.5.3 Pasteurisation, 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 to 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, this means a partly 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 means a heat treatment over 100 °C during very short times; it is especially applicable to low viscous liquid products.

Batch wise 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 is also 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.

BAT for Pasteurisation etc.

Application Form Question 2.3 (cont.) → Pasteurisation, Sterilisation, UHT

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

1. The main control issues are:
    - Water use - see Section 2.2.3.
        - The operator should justify why the reuse of “once through cooling” waters is not possible.
    - Cleaning techniques - see Section 2.3.10.
    - Fugitive emissions to air (refrigerants) - see Section 2.3.13.
    - Energy efficiency - see Section 2.7.
2. No further issues are identified.

Baking

2.3.6 Heat processing using hot air

2.3.6.1 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, pizza 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 2.3.5.1). The energy usage for baking normally ranges from 450 - 600 kJ/kg of product.

Accidents: Not applicable.

Noise: Not applicable.

Application Form Question 2.3 (cont.) → Baking

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

BAT for baking

Indicative BAT Requirements

1. The main control issues are:
   - Emissions to air - see Section 2.3.11.
     - low NOx burners.
   - Odour - see Section 2.3.15.
   - Energy efficiency - see Section 2.7.
2. No further issues are identified.

Roasting

2.3.6.2 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, 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 sufficient 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 depending on the product and the specific aromas that are required. Roasting times for coffee range between 1 and 20 minutes, for cacao and other product this 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 batch wise 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 by 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: VOC 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 10. Usually the overall average emission of VOC 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 to 1.5% of the amount of green coffee.

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

Accidents: Not applicable.

Noise: Not applicable.

Application Form Question 2.3 (cont.) | Roasting

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

BAT for roasting

Indicative BAT Requirements

1. The main control issues are:
   - Emissions to air - see Section 2.3.11.
   - Odour - see Section 2.3.15.
   - Energy efficiency - see Section 2.7.
2. No further issues are identified.

Drying etc.

2.3.6.3 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.

Hot air drying

Hot air is used as heating medium and is in direct 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,

Surface drying by heat conduction through a heat transfer system

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,
- and the process may be carried out in absence of oxygen.

The two main types of surface dryers are:

- drum (roller dryers),
- vacuum band/vacuum shelf dryers.

Fluidised bed dryers have 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 VOC, particulate and odour bag filters.

Water: Wastewaters from cleaning and wet scrubber systems.

Land: Deposition of particulate if air emission abatement is in adequate.

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

Energy: For evaporation of water theoretically 2.2 MJ/kg is required. Due 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: Failure of air emission abatement.

Noise: Not applicable.

Drying etc

Application Form Question 2.3 (cont.)

Drying

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT for drying

1. The main control issues are:
   - Emissions to air - see Section 2.3.11.
     - Typically exhaust air is passed through cyclones, however, the outlet air of cyclones may contain dust particles up to 200 mg/m^3 which will require secondary abatement, for example, fabric filters.
   - Odour - see Section 2.3.15.
   - Energy efficiency - see Section 2.7.
2. Various measures typically used to reduce heat losses and save energy can 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.

Frying

2.3.7 Heat processing using hot oils

2.3.7.1 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 varies according 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 as high as 6 minutes.

Environmental impact

Air: Emissions are dependent on operational temperature (in turn dependant 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 VOC and odour will be associated with the emission.

Water: Wastewater from cleaning which will contain fat both in the form of 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.

Application Form Question 2.3 (cont.) — Frying

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT for frying

1. The main control issues are:
   - Waste minimisation - see Section 2.2.2.
     - oil recovery to remove entrained oil from exhaust gasses
   - Emissions to air - see Section 2.3.11.
     - process control of the crisp frying process to ensure that the frying process ends when the final moisture content is in the critical range of 1-2%;
     - exhaust gas recirculation to the burner (see Figure 2-3).
   - Odour - see Section 2.3.15.
   - Energy efficiency - see Section 2.7.
     - heat exchangers mounted in the fryer exhaust hood.
2. No further issues are identified.

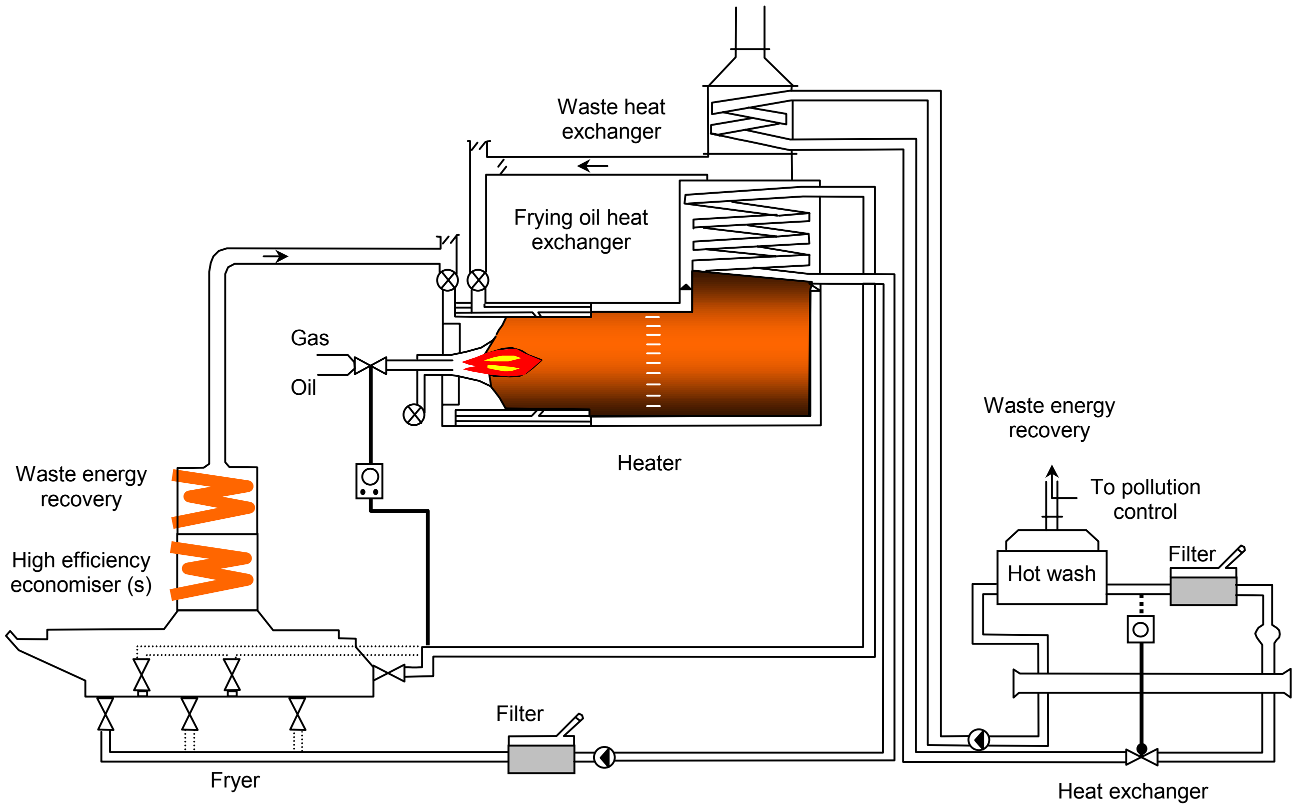


Figure 2-3 - Heat and Oil Recovery System
(Ref. 8)

Cooling, Chilling

2.3.8 Processing by the removal of heat

2.3.8.1 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 ground water, 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 is carried out by contacting the food with cold air or directly 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 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.

Application Form
Question 2.3 (cont.)

Cooling and Chilling

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT for cooling and, chilling

1. The main control issues are:
   - Water use - see Section 2.2.3.
     - The operator should justify why the reuse of "once through cooling" waters is not possible.
   - Cleaning techniques - see Section 2.3.10.
   - Fugitive emissions to air (refrigerants) - see Section 2.3.13.
   - Energy efficiency - see Section 2.7.
2. No further issues are identified.

Freezing

2.3.8.2 Freezing

Summary of the activities

Freezing is a method for preservation, where the temperature of a food is reduced below the freezing point 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.).

Description of techniques, methods and equipment

During the freezing process "sensible" heat 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. 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.

Application Form Question 2.3 (cont.) → Freezing

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT for freezing

1. The main control issues are:
   - Fugitive emissions to air (refrigerants) - see Section 2.3.13.
   - Energy efficiency - see Section 2.7.
2. No further issues are identified.

Freeze drying

2.3.8.3 Freeze drying

Summary of the activities

Lyophilization, commonly referred to as freeze drying, is the process of removing water from a product by sublimation and desorbtion. The aim of the process is to preserve sensitive material that cannot be dried by evaporation at elevated temperature because of the degradation of specific components at high temperature resulting is 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 lyophilization 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.

Application Form Question 2.3 (cont.) — Freeze Drying

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT for freeze drying

1. The main control issues are:
   - Fugitive emissions to air (refrigerants) - see Section 2.3.13.
   - Energy efficiency - see Section 2.7.
2. No further issues are identified.

2.3.9 Separation and concentration of food components

2.3.9.1 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 form 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 or 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, ethyl acetate and alcohol;
- supercritical CO_2.

Raw materials are usually pre-treated in order to ensure efficient extraction of desired compounds. For example, sugar beets and sugar cane is 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. Batch-wise 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 upwards under a certain slope. 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 next to recover 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 in the fields of:

- coffee,
- tea,
- hops,
- spices and
- flavours

Extraction

Summary of the activities (cont.)

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 dependant 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 super critical 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 obvious 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; and
- extraction of fat from potato crisps.

Environmental impact

Air: VOC 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 volatile organic matters 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 25 - 50 kWh per ton oilseed. For extraction of coffee a typical consumption per ton of dry solids is in a range of 3 to 6 tons of steam and 200 to 300 kWh electrical power.

Typical specific consumption for the water decaffeinating method are 5 to 10 tons of steam, 500 to 700 kWh 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 kW to 350 kW.

Accidents: Spillage of solvent.

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

Application Form Question 2.3 (cont.) — Extraction

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

BAT for extraction

Indicative BAT Requirements

1. The main control issues are:
   - Fugitive emissions to air (refrigerants) - see Section 2.3.13.
   - Water use - see Section 2.2.3.
   - Energy efficiency - see Section 2.7.
2. No further issues are identified.

Centrifugation

2.3.9.2 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 microns 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 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 and suitable control measures need to be put in place.

BAT for centrifugation

Application Form Question 2.3 (cont.) — Centrifugation

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

1. The main control issues are:
   - Energy efficiency - see Section 2.7.
   - Noise - see Section 2.9.
2. No further issues are identified.

Filtration

2.3.9.3 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 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 in a brewery.

Energy: Required for application of pressure or vacuum.

Accidents: Not applicable.

Noise: Not applicable.

Application Form Question 2.3 (cont.) | Filtration

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT for filtration

1. The main control issues are:
   - Wastewater treatment - see Section 2.3.11.3.
   - Waste handling and disposal - see Section 2.5.
   - Energy efficiency - see Section 2.7.
2. No further issues are identified.

Membrane separation

2.3.9.4 Membrane separation

Summary of the activities

Membrane separation aims at selective removal of water (and solutes) from a solution by using semi-permeable membranes. So it can also be seen as a fractionation technique. We can distinguish membrane filtration and electro dialysis; both are membrane separation techniques.

Membrane separation is applied for concentration of liquids (for example cheese whey), de-mineralisation 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):

- Micro Filtration (MF) pore size range 0.1 µm to 5 µm can be used to remove bacteria from skim milk during the production of ultra clean milks, or for fractionation skim milk into a casein rich retentate and a milk serum devoid of casein;
- Ultrafiltration (UF) pore size range 10 - 100 nm and 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, and are 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 de watering, 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. Principle application within the dairy industry is for demineralisation of whey.

Environmental impact

Air: Not applicable.

Water: Handling of permeate (if not reused), and cleaning.

Land: No direct impacts.

Waste: Handling and disposal of concentrate.

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

Accidents: Not applicable.

Noise: Not applicable.

Application Form Question 2.3 (cont.)

Membrane Separation

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT for membrane separation

1. The main control issues are:
   - Wastewater treatment - see Section 2.3.11.3.
   - Waste handling and disposal - see Section 2.5.
   - Energy efficiency - see Section 2.7.
2. No further issues are identified.

Cleaning & sanitation

Summary of the activities

2.3.10 Cleaning and sanitation

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 reused for pre-rinsing. In CIP-cleaning high temperatures (up to 90 °C) are used and strong cleaning agents.

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 – 2nd bullet).

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; 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 is 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 flush raw materials and product directly down the drain, believing that a subsequent screen or catch pot 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 break down 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 food and drink industry are alkalis (sodium and potassium hydroxide, metasilicate, sodium carbonate), acids (nitric acid, phosphoric acid, citric acid, gluconic acid) composed cleaning agents containing chelating agents (EDTA, NTA, phosphates, polyphosphates, phosphonates) and surface-active agents.

Cleaning & sanitation

Sanitation chemicals and techniques

Summary of the activities (cont.)

Oxidizing biocides oxidise the bacterial cells 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. This situation is further complicated by the formation of "chloramines" and other organo-halogen compounds, many of which are dangerous to living organisms, and the discharge of which will be tightly controlled within the receiving water.

The use of ozone is also increasing for disinfecting purposes.

Non-oxidizing 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 includes, 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 dependant on the transmittance (i.e. compounds which can absorb and reduce UV light effectiveness) of the wastewater stream. UV light is also an immediate reaction that 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 transmisivity) 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 form the equipment that is cleaned.

Land: No direct impacts.

Waste: Not applicable.

Energy: Cleaning is commonly carried out at elevated temperatures utilizing 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.

Application Form Question 2.3 (cont.) → Cleaning and Sanitation

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 listed on page 25 for this aspect of the activities;

Indicative BAT Requirements

BAT for cleaning & sanitation

1. The single most important factor is 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.

Cont.

Cleaning & sanitation

BAT for cleaning & sanitation (cont.)

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

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:

2. 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);
   - 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.

3. 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.

4. 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 wash down water.
   - Use of high pressure/low volume systems.

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

6. 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.

7. Sanitisation:
   - The operator should justify the use of organo-halogen based oxidising biocides over the alternatives, for example ozone and UV light.

8. Recycling of water and recovery of cleaning chemicals - see Section 2.2.2.2.

Abatement to air

2.3.11 Abatement of point source emissions to air

Nature of the emissions

The nature of the emissions from each example activity is given in previous sections. In general they comprise:

Activity	Pollutant			
	VOC	Odour	Particulate	SOx, NOx,
Receiving and handling of raw materials (section 2.3.1)		✓	✓	
Preparation of raw materials				
Dry cleaning			✓	
Peeling	✓	✓		
Mixing (of dry powders)			✓	
Extrusion	✓	✓		
Heat processing using steam or water				
Blanching	✓	✓		
Evaporation	✓	✓	✓	
Pasteurisation/Sterilisation		✓		
Heat processing using hot air				
Drying	✓	✓	✓	
Baking and roasting		✓		✓
Frying	✓	✓		✓
Grinding and milling			✓	
Solvent extraction	✓			
Combustion plant				✓
Effluent treatment systems		✓		

The distinction between emissions of VOC/odour and particulate/odour are not always clear. Where odour (see section 2.3.15) may be an issue, the cause will typically be emissions of VOC (sometimes at low concentrations). Measures taken to prevent or reduce VOC will also lead to a reduction in odour and similarly for particulate.

Application Form Question 2.3 (cont.) — Control of Point Source Emissions to Air

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 on page 25 for control and abatement equipment; and in addition
2. describe the measures and procedures in place and proposed to prevent or reduce point source emissions to air. This should include, but is not limited to, the general measures described below.
3. justify where any of the measures are not employed. Guidance on abatement techniques for point source emissions to air can be found in References (see Ref. 10).
4. where VOCs are released, the identification of the main chemical constituents of the emissions and assessment of the fate of these chemicals in the environment. These steps will be carried out as in response to Sections 3.1 and 4.1 but need to be understood here in order to demonstrate that the controls are adequate.

BAT for abatement of point sources to air

Indicative BAT Requirements

2.3.11.1 General techniques

1. The operator should provide the following with the application as appropriate. If in there is doubt, the degree of detail required should be established in pre-application discussions:
   - a description of the abatement equipment for the activity;

Cont.

Abatement to air

BAT for abatement of point sources to air (cont.)

- 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 2.3.15 Odour - identification of constituent components may not always be practicable for VOCs where concentrations are low);
- measures to increase the security with which the required performance is delivered;
- measures to ensure that there is adequate dispersion of the emission(s) to prevent exceedances of 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;
- damage to health or soil or terrestrial ecosystems.

2. The operator should demonstrate that an appropriate assessment of vent and chimney heights has been made. Guidance is given in Technical Guidance Note D1 (see Ref.14). and may need to be supported by more detailed dispersion modelling as described in Section 4.1.

3. Where appropriate the operator should also recognise the chimney or vent as an emergency emission point and 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 serious damage to health. The impact of fugitive emissions can also be assessed in many cases

4. ***Steam plume elimination*** - Releases from for example, evaporators or wet scrubber vents should be hot enough to avoid visible plume formation in the vicinity of the vent. This is to prevent the condensation or adsorption of environmentally harmful substances by the condensing water vapour. Exhaust gases from a wet scrubber can be heated by the use of waste heat to raise the temperature of the exhaust gases and prevent immediate condensation on the exit from the vent. This procedure also aids the thermal buoyancy of the plume. Where there is no available waste heat and the vent contains no significant environmentally harmful substances, the applicant may be able to demonstrate that the BAT criteria have nonetheless been met.

2.3.11.2 Techniques for the Food and Drink sector

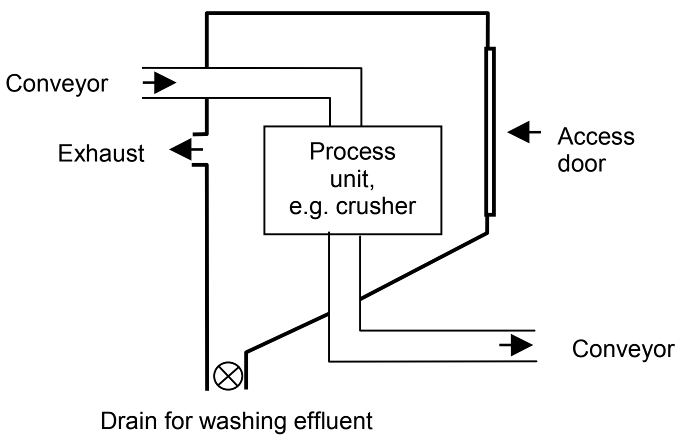
5. Air movements around loading/unloading and transfer points for dry powders and grain etc. are a significant source of dust emissions. Orientation of the plant and installation of roll down or bi-fold doors will reduce wind effects.

Enclosure

6. Largely 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 drop losses etc. Optimum containment of odorous or polluted air is therefore important in either eliminating the need to treat the air or in 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 2-4 and Figure 2-5.

Cont.

Figure 2-4 - Example of Enclosure of a Food Processing Unit



Abatement to air

Figure 2-5 - Example of Enclosure of a Conveyor System (also see Section 2.3.1)

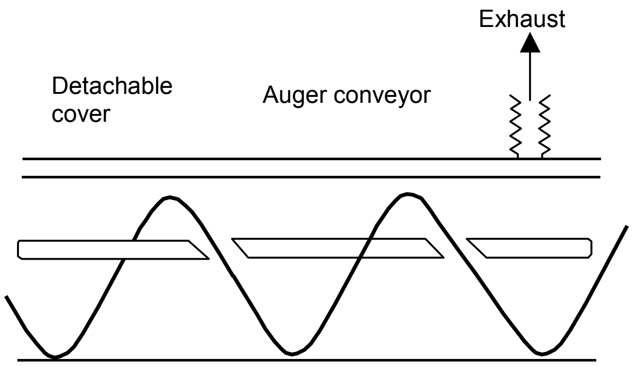


Table 2-2 - Abatement Options for Specified Pollutants

Activity	Abatement options for specified pollutants			
	VOC	**Odour**	**Particulate**	**SOx, NOx,**
Receiving and handling of raw materials (#1) (#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 section 2.3.11.3
Frying	Ab, Ad, C, TO, BO, CO			See section 2.3.11.3
Grinding and milling			Cy, FF	
Solvent extraction	Ad, C, TO, BO, CO			
Combustion plant				See section 2.3.11.4
Effluent treatment systems		Ad, C, TO, BO, CO		

See Table 2-3 for Abatement Options key

#1 In addition to enclosure, emissions from conveyor systems can 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 choke flow system will reduce these emissions.

Abatement to air

Table 2-3 - Abatement Options Key

Key	Name	Comment
Ab	Absorption	Suitable for high flow, low concentrations (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 1kg 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 > 30s. For a gas flow of 150000 Nm^3/hr, a reactor volume of approximately 1250 m^3 would be required. The available surface area maybe the limiting factor. Variability in gas flowrate, gas composition in terms of available organic constituents, pH, temperature and humidity may be difficult to manage.
CO	Catalytic oxidation	Suitable for airflow range 150 - 70,000m^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 reliably. Not effective against particle sizes <10um. 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.

BAT for abatement of point sources to air (cont.)

2.3.11.3 Processes using heat

7. 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 is a technique for reducing NOx emissions in the release to atmosphere, see Figure 2-3.

2.3.11.4 Combustion processes

8. Where there is an on-site combustion plant other guidance is also relevant. For plants greater than 50 MW operators should consult the IPPC guidance on power generation (reference S2 1.01 and supplement S3 1.01) and the operators of plants of 20-50 MW should consult the Local Authority Air Pollution Control guidance. On IPPC installations this guidance will be generally applicable to plant under 20 MW also. For incineration plant S2 5.01 Waste Incineration should be consulted.

   There may also be other sources of combustion gases such as direct gas fired drying equipment. In such cases low NOx burners should be employed.

   For the relationship of pollution control on combustion plant to energy efficiency issues and any Climate Change Levy agreements see Section 2.7.

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

Effluent treatment

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

2.3.12.1 Nature of the effluent

Summary of the activities

The nature of the emissions from each example activity is given in sections 2.3.1 to 2.3.11. A number of other general sources are identified in section 2.2.3. Others include:

- blowdown from steam boilers;
- once-through cooling water or bleed from closed loop cooling water systems;
- 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 sub-sector, for example, in the order of 10m^3 of wastewater is generated for every tonne of raw material processed. Wastewater flowrates 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 waste minimisation techniques (see Section 2.2.3) and Tertiary Treatment methods (see Section 2.3.12.7). ***It is, however, imperative that water conservation measures do not lead to unsatisfactory levels of cleanliness, hygiene or product quality.***

Wastewater from the Food & 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, cheesemaking);
- 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. BOD is directly associated with levels of product in the wastewater and is therefore an indication of inefficient processing. The BOD content of the main food constituents is:

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 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.

Summary of the activities (cont.)

Wastewater from the dairy, meat, fish, baking and edible oil extraction sub-sectors and from the manufacture of oily foods such as margarine and salad dressings has 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:

1 Surface waters means controlled waters (Water Resources Act 1991) but excludes ground waters (waters contained in under ground strata) which are covered in Section 2.4

In the PPC regulations 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.

- the natural pH of the raw material;
- pH adjustment of flaming water to prevent raw material deterioration;
- use of caustic or acid solutions in processing operations;
- use of caustic or acid solution 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.

Application Form Question 2.3 (cont.)

Effluent Treatment

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 on page 25 to prevent or reduce point source emissions to water and land; and in addition
2. include, where appropriate, off site treatment in the description of the wastewater treatment system for the activity;
3. provide, where effluent is discharged, a justification for not cleaning the effluent to a level at which it can be reused (e.g. by ultrafiltration where appropriate);
4. describe measures taken to increase the reliability with which the required control and abatement performance is delivered (there may be a biological plant susceptible bulking or poisoning – what measures ensure reliability?, heavy metals are measured only occasionally – what techniques ensure that they are controlled all the time? etc.);
5. identify the main chemical constituents of the treated effluent (including the make-up of the COD) and assessment of the fate of these chemicals in the environment. These steps will be carried out as in response to Sections 3.1 and 4.1 but need to be understood here in order to demonstrate that the controls are adequate. This applies whether treatment is on- or off-site;
6. identify the toxicity of the treated effluent (see Section 2.10). Until the Regulator's toxicity guidance is available, this should, unless already in hand, normally be carried out as part of an improvement programme;
7. where there are harmful substances or levels of residual toxicity, identify the causes of the toxicity and the techniques proposed to reduce the potential impacts;
8. consider of whether the effluent flow is sufficient to fall within the requirements of the Urban Waste Water Treatment Directive.

Cont.

Effluent treatment

BAT for effluent treatment

Indicative BAT Requirements

1. The operator should complete any detailed studies required into abatement or control options (see item 3 in Section 2.3) 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;

2. The operator should describe the measures and procedures in place and proposed to prevent or reduce 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.

   The application should include:
   - a description of the wastewater treatment system for the activity;
   - justification for not cleaning the effluent to a level by which it can be reused, (for example by ultrafiltration where appropriate);
   - the identification of the main chemical constituents of the treated effluent (the make up of the COD) and assessment of the fate of these chemicals in the aquatic environment. This applies whether treatment is on or off site;
   - 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.

2.3.12.2 General Water Treatment Techniques

3. The following general principles should be applied in sequence to control emissions to water:
   - water use should be minimised and waste water reused or recycled (see Section 2.2.3).
   - techniques to minimise contamination risk of process or surface water, should be implemented, see Sections 2.3.12.3 and 2.3.12.4;
   - 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;
   - systems should be engineered to avoid emissions to water by-passing the treatment plant.

4. 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 References, (see Ref. 11).

5. All emissions must be controlled to avoid breach of water quality standards, (see Section 3.2). Calculations and/or modelling should be supplied to demonstrate this, (see Section 4.1).

6. Where effluent is treated off site, the above factors apply in particular demonstrating that:
   - all appropriate measures have been taken to reduce effluent and volume strength, for example through optimisation of water use and product loss;
   - the treatment provided at the sewage treatment works is as good as would be achieved if the emission was treated on site, based on reduction of load (not concentration) of each substance to the receiving water;
   - the probability of sewer bypass, via storm/emergency or combined sewer overflows or at intermediate sewage pumping stations is acceptably low;
   - a suitable monitoring programme for emissions to sewer, taking into consideration the potential inhibition of any downstream biological processes.

2.3.12.3 Water Treatment for the Food and Drink sector

The following paragraphs apply generically to any food and drink installation and technically associated activities. Further details applicable to specific food and drink sectors follow.

Cont.

Effluent treatment

BAT for effluent treatment (cont.)

7. 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 2.2.3). The operator should justify the choice and performance of the effluent management system for the plant against the following factors. See Figure 2-6 for a schematic representation of effluent treatment

Classification	Objective	Techniques
Opportunities to reduce waste water loading	To keep raw materials and product out of the wastewater stream (see Section 2.3.12.2) Reduce fluctuations in effluent flow and strength Prevent damage to treatment plant	Dry Cleaning Installation and maintenance of drain catchpots Flow equalisation Diversion tanks
Primary treatment Section 2.3.12.5 *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) Removal of suspended solids	Screening Centrifugation Gravity settlement Air Flotation
Secondary treatment Section 2.3.12.6	Removal of BOD Sludge treatment and disposal	Aerobic treatment Anaerobic treatment Thickening and dewatering
Tertiary treatment Section 2.3.12.7	Water quality standards and recycling of water	Macrofiltration Membranes

2.3.12.4 Preliminary Techniques

8. Wherever possible raw materials and product should be kept out of the wastewater system (see Section 2.3.12.2). After dry clean up techniques, the next measure is the installation of drain catchpots and screens. Where gross FOG (Fat Oil Grease) is found 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.

Flow balancing and equalisation:

9. 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 forward feeding 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 waste water 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).

   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. If no balancing is provided, the operator should show how peak loads are handled without overloading the capacity of the wastewater treatment plant

   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 waste water streams to enable the final waste water 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 waste water. 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.

Diversion tanks

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

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

Cont.

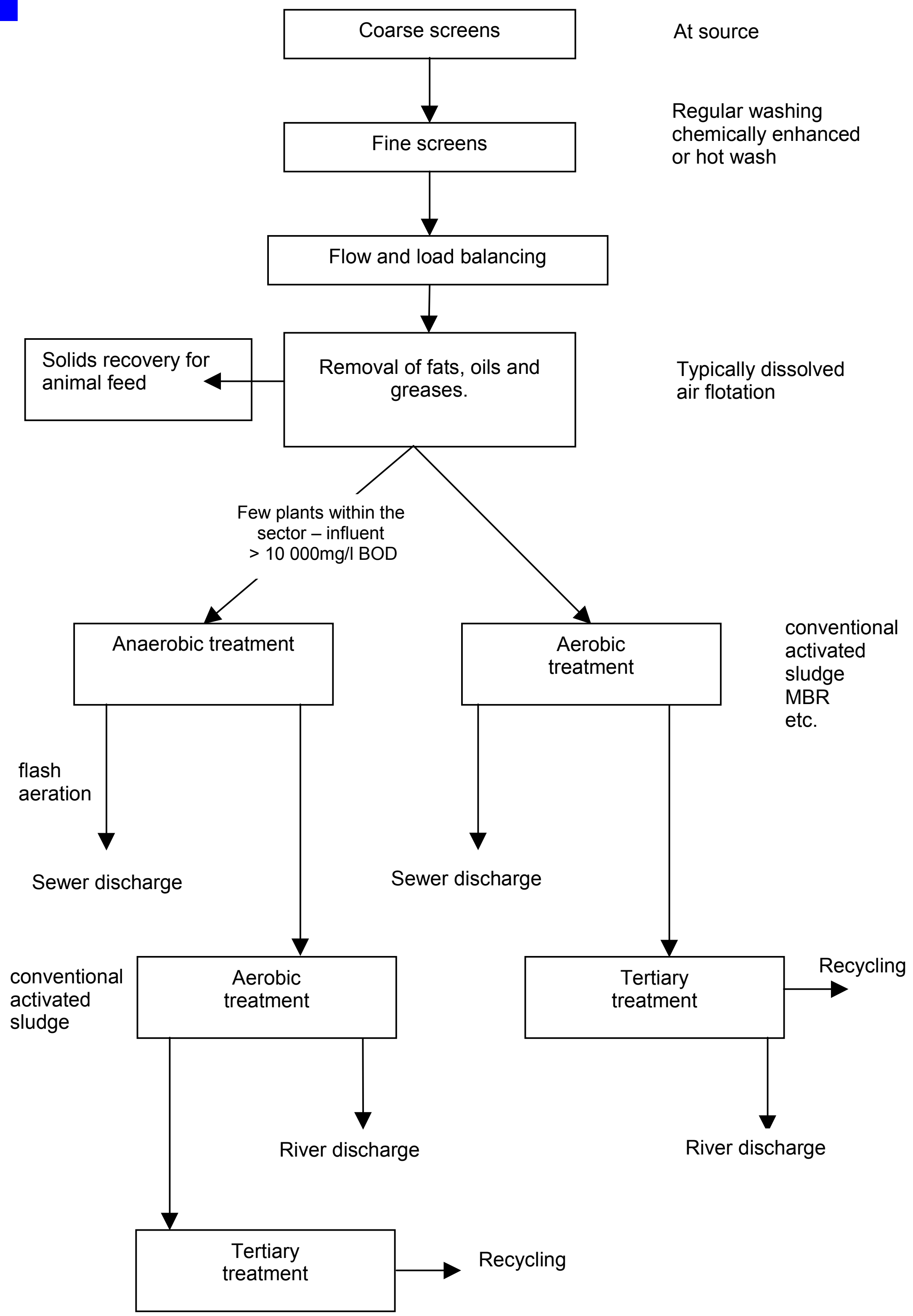


Figure 2-6 - A Typical Schematic for a Process Flow Diagram for Effluent Treatment Applicable to Food and Drink Processing Wastewaters

Effluent treatment

BAT for effluent treatment (cont.)

A diversion tank capable of receiving typically a 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 as 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.

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.

2.3.12.5 Primary Treatment

11. 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 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 life span of the installation.

Screens

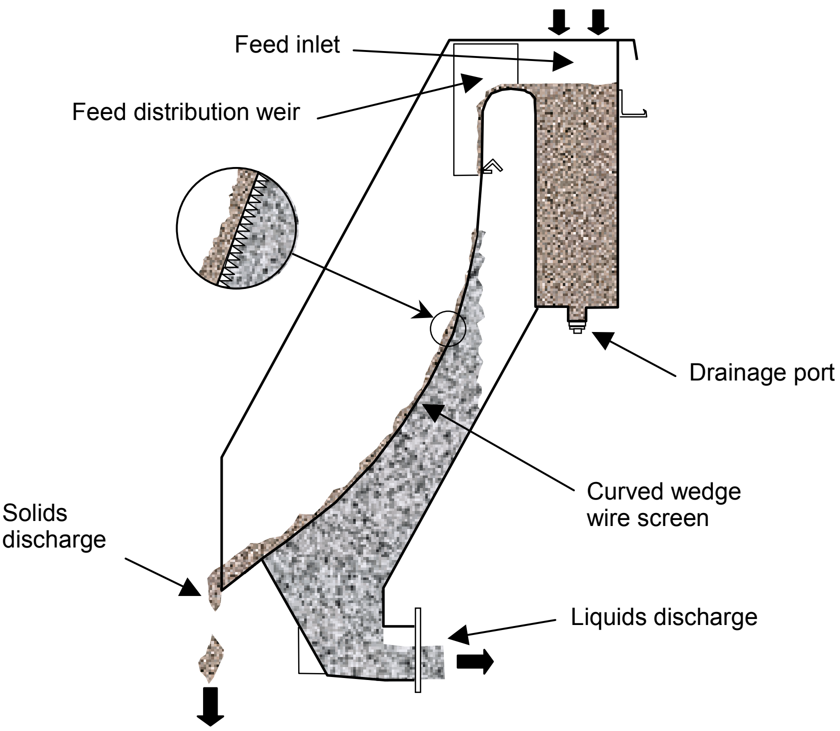
12. Interception of the waste materials by various types of screens should be the first step in decreasing the solids loading of the wastewater. Drains and grates in operational areas should be fitted with catch pots.

    Subsequent screens should be placed on wastewater streams as near to the process end of the drains as possible. The main types of screens used are static (brushed or run-down screens) coarse or fine, vibrating and rotary screens.

    a) A typical static wedge screen is shown in Figure 2-7. The effluent is pumped, or flows by gravity, to the top of the screen. Liquid drains through the screen and solids are collected at the bottom for separate disposal. Static wedge screens are generally cheaper than vibrating and rotary drum screens, but require more maintenance.

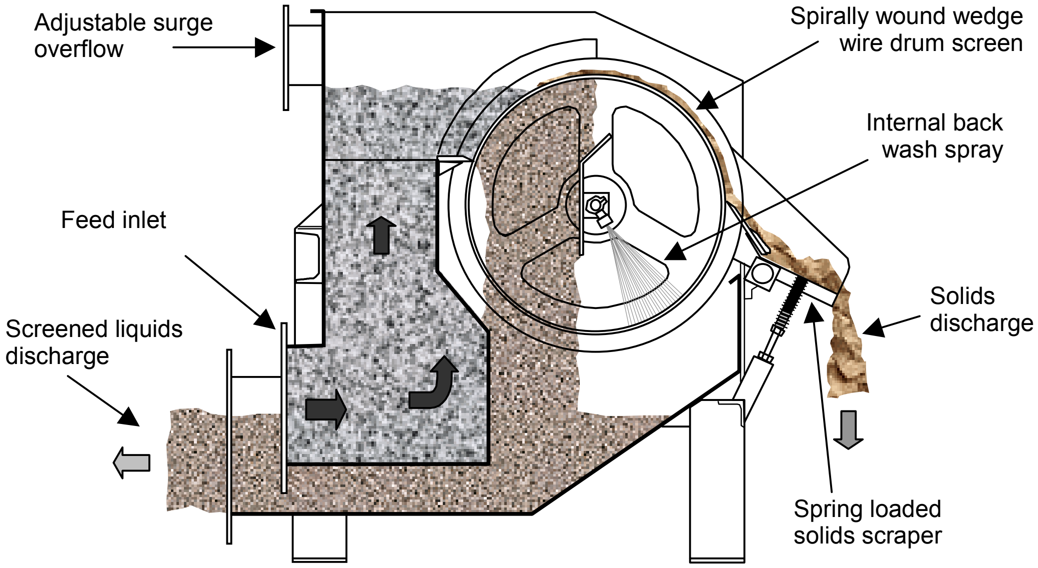
Cont.

Figure 2-7 - Static Wedge Screen



Effluent treatment

Figure 2-8 - Example of a Rotary Drum Screen



BAT for effluent treatment (cont.)

b) Vibrating screens depend on a rapid motion for their effectiveness. Normal applications are for pre-treatment associated with by-product recovery, particularly of solids with a low moisture content, and preferably not where the waste water contains grease. Of prime importance in the selection of a proper fine vibrating screen is the application of the proper cloth, that is cloth with the correct combination of strength of wire and percent of open area. The capacities of vibrating screens are based on the percent of open area of the filter media.

There are a variety of different rotary drum screens available. In some systems the effluent is loaded inside the drum but more commonly the effluent flows over the external surface of the drum. Rotary drum screens typically have a mesh size of between 3mm and 4mm, but in some cases can be as small as 1.5 mm. In the rotary knife system the action of the drum lifts the solids from one side of the screen to the other where they are removed by a spring-loaded scraper for collection into a skip, see Figure 2.8. The screened liquid falls through the drum and is discharged to foul sewer or further treatment in an on-site effluent treatment plant. A spray bar located inside the drum cleans the screen as the drum rotates.

Rotary drum screens are typically between 2 and 3 times the cost of static wedge screens but have the benefit of being self-cleaning and generally require less maintenance.

The exact mesh size used on the initial screening process is obviously dependent on the nature of the insoluble material that requires removal. Typical mesh sizes for fine screens would be in the region of 0.25-10mm.

Principles of operation

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

14. 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.

15. Overloading may be a factor where surface water drains are connected to the waste water 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.

16. Flow equalisation may be needed preceding screening equipment to avoid overloading and bypassing the screen.

17. 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.

Cont.

Effluent treatment

BAT for effluent treatment (cont.)

Settlement

18. 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. The efficiency of the sedimentation process is affected by the wastewater and suspended solids characteristics, variation in flow, and general operation. The solids may be discrete suspended particles that are self-settling, or there may be of a range of sizes and surface characteristics, which require the formation of flocculating suspensions to coagulate and settle the mass, through chemical conditioning. 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.

Settlement can be enhanced through coagulation and flocculation of the solids to improve their settling characteristics, or by the introduction of lamella plates that effectively increase the settlement area available without increasing the physical size of the clarifier. Coagulation involves the chemical destabilisation of the particles and flocculation is the physical process that agglomerates particles too small for gravitational settling.

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 also contains pectic substances that may do this.

Air flotation

19. 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, see Figure 2.9.

Cont.

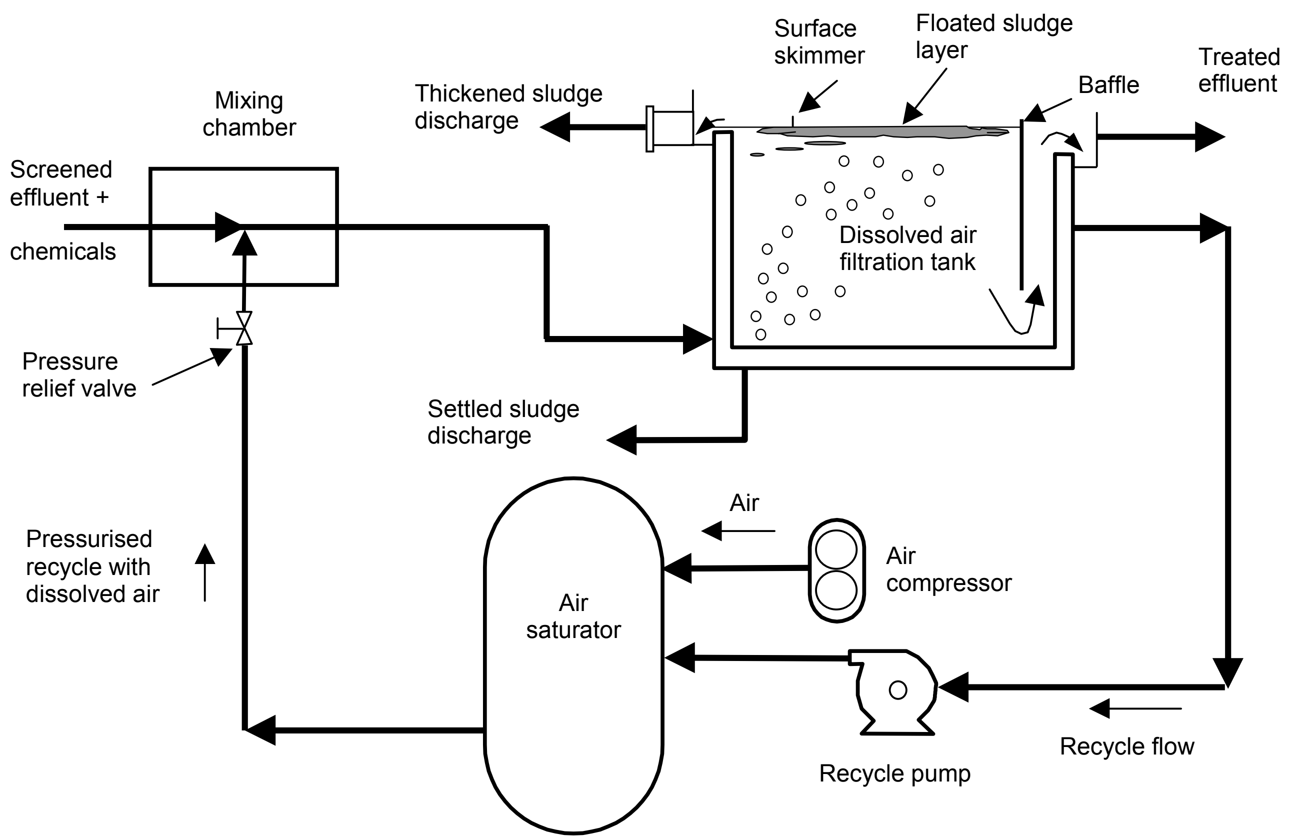


Figure 2-9 - Principle Components of Dissolved Air Flotation

BAT for effluent treatment (cont.)

The basic mechanism of air flotation is to introduce small air bubbles into the waste water containing the suspended solids to be floated. The fine air bubbles attach themselves to the chemically conditioned particles and hence the solids float to the surface, where they are accumulated, thickened and removed by mechanical skimming or suction withdrawal. Usually chemicals such as polymers, aluminium sulphate or ferric chloride are used to enhance the adhesion of bubbles. The method of air supply is used to define the process.

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.

Dissolved Air Flotation (DAF) is most widely used because of its effectiveness in removing a range of solids. The DAF system generates a supersaturated solution of waste water and compressed air by raising the pressure of the waste water stream to that of the compressed air, then mixing the two in a retention tank. This supersaturated mixture of air and waste water flows to a large flotation tank where the pressure is released, thereby generating numerous small air bubbles. Through a combination of adsorption and entrapment, the flocculated particles rise to the surface of the reactor. The suspended solids float to the top of the liquid and form a foam that is then skimmed off. Some soluble colloidal substances are removed from the waste water by adding coagulation and flocculation chemicals (e.g. iron salts, aluminium salts and polyelectrolytes) to form precipitates with the solutes.

Other flotation techniques include:

- Vacuum flotation that 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.

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

20. There are three main types of centrifuge available;
    - solid bowl,
    - basket,
    - disk-nozzle.

    The disk-nozzle configuration is primarily used for liquid/liquid separation.

    The basket and solid bowl centrifuges dewater in a batch process. The solid bowl configuration relies on the supernatant liquors to either be scraped from the surface or over-top a weir arrangement at the top of the centrifuge. The basket system uses a perforated mesh hence the liquid phase passes through the filter medium during centrifugation.

2.3.12.6 Secondary Treatment

21. 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.

22. The basic alternatives are aerobic and anaerobic biological systems. There are many designs of each.

Cont.

Effluent treatment

BAT for effluent treatment (cont.)

The operator should justify the choice and performance of the secondary treatment plant against the following factors:

Anaerobic treatment is not widely used within the sector and tends to be restricted to effluents > 10 000 mg/l BOD, where production of biogas is economically favourable.

An anaerobic system 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.

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 or bulking.

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.

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

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

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.

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.

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

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

Common operational problems experienced with anaerobic treatment processes are;

- 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 mesophillic 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 is essential.
- Overloading. Care should be taken to ensure the original hydraulic and loading design rates do not exceed the manufacturer’s recommendations.

Whichever design of primary and secondary plant is used, it should be able to achieve the Benchmarks.

Cont.

Table 2-4 - Summary of Aerobic and Anaerobic Treatment Processes

Aerobic	
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 or 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 Section 2.3.12.8).
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 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 Bio-reactors (MBR)	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 12-25,000 mg/l), resulting in more compact plant sizes and accelerated removal rates.
Sequencing Batch Reactor (SBR)	SBR are essentially "fill and draw" processes that gave 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 a 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 limited to <1 500 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 is incorporated into the design.
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, 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 3-phase separator arrangements are used to separate the final effluent from the solids (biomass) and the biogas. Loadings of up to 60kg/m^3/day have been reported, but more typical data would be a loading rate of 10kg/m^3/day with an HRT of 4hr. UASB is not suitable for effluent containing high solids or FOG.
	Some recent advances in anaerobic treatment technology has seen a number of variations of the process developed and successfully marketed in the UK;
The IC 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 to be in the range of 15-35 kgCOD/m^3.d.
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 to be in the range of 15-35 kgCOD/m^3.d.
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.

Effluent treatment

BAT for effluent treatment (cont.)

2.3.12.7 Tertiary treatment

23. Tertiary treatment refers to any process that is considered a "polishing" phase after the secondary treatment techniques up to and including disinfection and sterilisation systems. The need for tertiary treatment is dictated by two potential factors:

- the requirement to meet discharge conditions based on Environmental Quality Standards (EQS) which may be stricter than the requirements of BAT, relevant substances include *ammonia, List I and List II substances and suspended solids:*
- recycling of water back into the factory either as process water or wash water.

There are two categories of Tertiary Treatment Processes:

Macrofltration

24. Macro filtration 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.

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.

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

25. 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 waste water. The technology is applied for example in the dairy industry to recover milk as a useable by-product from wastewaters 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 (crossflow microfiltration), or very small for the removal of inorganic salts or organic molecules (ultrafiltration or reverse osmosis). 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.

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

- Micro filtration
- Ultra filtration
- Nano filtration
- Reverse Osmosis

Cont.

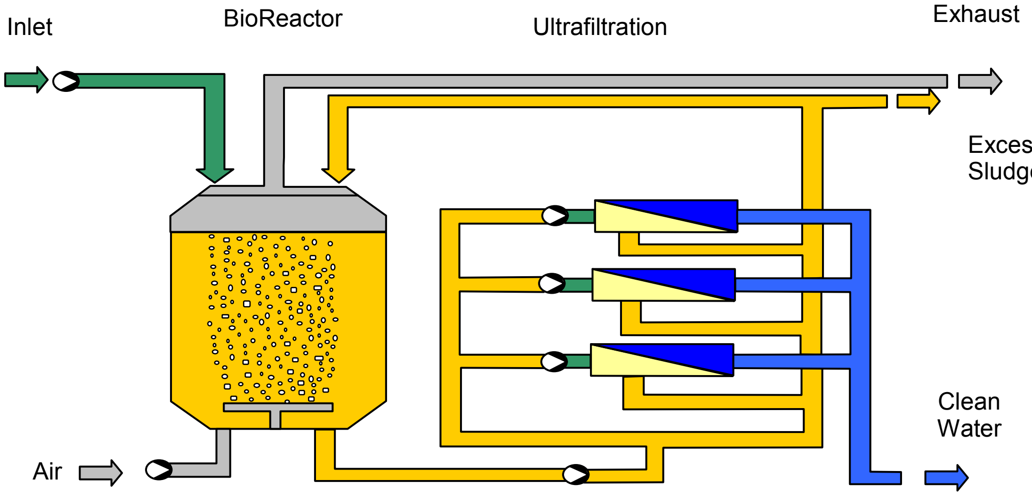


Figure 2-10 - Example of Membrane Bioreactor (MBR) at a Dairy

Effluent treatment

Table 2-5 - Comparison of Performance Data for MBR Plant and Conventional Activated Sludge Plant

	MBR	**AS**
Tank volume required for the process biology	2,000 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

BAT for effluent treatment (cont.)

2.3.12.8 Sludge Treatment and Disposal

26. Sludge treatment and disposal is 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) may also be disrupted by weather conditions i.e. a period of heavy rain, which means that suitable storage capacity may be a factor.

Before considering on-site sludge treatment and potential disposal routes, the plant 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.

It has already been seen in Section 2.3.12.5 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.

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

27. Sludge treatment techniques are generally employed to either 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

28. 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.

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.

Cont.

Effluent treatment

BAT for effluent treatment (cont.)

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 rather than a low tank with a large surface area.
- Depending upon the details of the primary solids/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 gasses 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.

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.

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

29. 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 20-50% dry solids which will in turn significantly reduce disposal costs.

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 the plant operators should also become familiar with this apparatus to regularly monitor plant performance against chemical usage.

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.
- *The belt press* is a continuous process with the filter cloth continually running through rollers that forcefully dewater the sludge. Performance optimisation does require regular and specialised maintenance. A belt press can produce up to 35% dry solids cake. Chemical costs 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.

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

Fugitives

2.3.13 Control of fugitive emissions to air

On many installations, fugitive, or diffuse, emissions may be more significant than point source emissions, particularly where sources are unenclosed (see Section 2.3.11). In addition to the sources referred to in section 2.3.11, other examples of the sources of fugitive emissions include:

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

Application Form Question 2.3 (cont.) | Fugitive Emissions to Air

With the Application the operator should:

30. supply the general Application requirements for Section 2.3 on page 25 for control of fugitive emissions to air; and in addition,

31. identify, and where possible quantify, significant fugitive emissions to air from all relevant sources, including those below, estimating the proportion of total emissions which are attributable to fugitive releases for each substance; these steps will be carried out as in response to Section 3.1 but need to be understood here in order to demonstrate that the controls are adequate.

Indicative BAT Requirements

BAT for fugitive emissions to air

1. The operator should complete any detailed studies required into abatement or control options (see item 3 in Section 2.3) 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.

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

3. The operator should maintain an inventory (which may be submitted as part of the response to Section 3.1), quantified where possible, of significant fugitive emissions to air.

4. The operator should estimate 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 to be submitted on a regular basis.

5. The following general techniques should be employed where appropriate:
   - transferring materials on demand rather than in individual batch containers;
   - minimising potential for spillage through the use of well maintained and well designed pipe couplings;
   - minimising exposed surface areas of stored materials;
   - maintaining pumps, seals, glands and flanges;
   - improved scheduling of material deliver, collection and processing;
   - covering of skips and vessels;
   - avoidance of outdoor or uncovered stockpiles (where possible);
   - where unavoidable, use of sprays, binders, stockpile management techniques, windbreaks etc.;
   - wheel and road cleaning (avoiding transfer of pollution to water and wind blow);
   - closed conveyors, pneumatic conveying (noting the higher energy needs), and minimising drops;
   - regular housekeeping.

Cont.

Fugitives

6. **VOCs** (sectors using organic solvents)
   - When transferring volatile liquids, the following techniques should be employed - subsurface filling via 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, e.g. pressure/vacuum valves, and, where relevant, should be fitted with knock-out pots and appropriate abatement equipment.

7. **Odour** - see Section 2.3.15.

For existing activities, the above standards should be met within the timescale given in Section 1.1.

Chilling and Freezing Equipment

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

Application Form Question 2.3 (cont.) | Fugitive Emissions to Air in Relation to Chilling and Freezing Equipment

BAT

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 on page 25 for control of fugitive emissions to air in relation to chilling and freezing equipment.

Indicative BAT Requirements

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 leakage incidents.
   - Monitor plant performance.

2. **Under no circumstances should refrigerants be vented to the atmosphere**.

For existing activities, the above standards should be met within the timescale given in Section 1.1.

Fugitives

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

The environment also includes the land and while many of the measures described below have the objective of preventing and controlling pollution of the water environment, they will also serve to protect the land. It is a requirement of IPPC that upon definitive cessation of activities that the site of operation is returned to a satisfactory state, which includes the removal of any land contamination (see section 2.11).

Application Form Question 2.3 (cont.) → Fugitive Emissions to Water

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 on page 25 for control of fugitive emissions to air; and in addition,
2. identify, and quantify where possible quantify, significant fugitive emissions to water from all relevant sources, estimating the proportion of total emissions which are attributable to fugitive releases for each substance; These steps will be carried out as in response to Section 3.1 but need to be understood here in order to demonstrate that the controls are adequate.

Indicative BAT Requirements

BAT for fugitive emissions to water

1. Where there are opportunities for reductions, the Permit may require the updated inventory of fugitive emissions to be submitted on a regular basis.
2. 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

3. ***Designated cleaning areas***
   - designated and clearly marked cleaning area 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.
4. ***Subsurface structures***
   - the sources, direction and destination of all installation drains should be established and recorded and up to date plans kept on site;
   - all gullies, grids and manhole covers should be colour coded, blue for surface water and red for foul drains. Notices should be used where appropriate and a set of up-to-date drainage plans kept on site;
   - drains should be of a construction to withstand the cleaning materials which may be utilised within the installation;
   - the sources, direction and destination of all subsurface pipework should be established and recorded and up to date plans kept on site;
   - all subsurface sumps and storage vessels should be identified;
   - systems should be engineered to ensure leakages from pipes etc are minimised and where these occur, can be readily detected, particularly where hazardous (e.g. listed) substances are involved;
   - in particular, secondary containment and/or leakage detection should be provided for such subsurface pipework, sumps and storage vessels;
   - an inspection and maintenance programme should be established for all subsurface structures, e.g. pressure tests or CCTV.
5. ***Surfacing***
   - a description of the design (#), construction and condition of the surfacing of all operational areas should be provided;
   - there should be an inspection and maintenance programme of all impervious surfaces and spill containment kerbs;

Cont.

- justification should be given where operational areas have not been equipped with:
  - an impervious surface;
  - spill containment kerbs;
  - sealed construction joints;
  - connection to a sealed drainage system;
  - covered (roofed) areas to minimise surface run off.

(# Relevant information may include as appropriate: capacities; thicknesses; falls; material; permeability; strength/reinforcement; resistance to chemical attack; inspection and maintenance procedures; and quality assurance procedures.)

6. ***Bunds***

Bunds should be provided for all tanks containing liquids whose spillage could be harmful to the environment. Bunds should:

- be impermeable and resistant to the stored materials;
- have no outlet (i.e. no drains or taps) and drain to a blind collection point;
- have pipework routed within bunded areas with no penetration of contained surfaces by pipes or ducts;
- be designed to catch leaks from tanks, or fittings;
- have a capacity of 110% of the largest tank or 25% of the total tankage, whichever is the greater;
- 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;
- have fill points within the bund where possible or otherwise provide adequate containment;
- have a routine programmed visual inspection of bunds including water testing where structural integrity is in doubt.
- Further information on bund sizing and design can be found in (Ref. 12) and (Ref. 13).

7. There are no other issues for this sector.

For existing activities, the above standards should be met within the timescale given in Section 1.1.

Odour

2.3.15 Odour

In the food and drink sector as perhaps no other, the subject of odour receives particular attention. The production of everyday staples such as bread, beer and chocolate to name but a few, produce evocative odours and most installations have the potential for odour problems.

Application Form Question 2.3 (cont.) | Odour Control

With the Application the operator should:

1. supply the general Application requirements for Section 2.3 on page 25 for odour control; and in addition, where odour could potentially be a problem, the operator should:

BAT for odour control

2. maintain an Odour Management Plan which should:
   - ***(a)*** ***Categorise the emissions*** as:
     - ***1.*** ***Release is expected to be acknowledged in the Permit*** – i.e. there will be a permitted release from the process (e.g. releases form contained or defined sources such cookers, dryers and combustion plant) and an element of BAT is adequate dispersion between source and receptor to prevent odour nuisance. The release is permitted and, under certain conditions, the plume may ground causing odour problems. Conditions in permits are likely to be based on the actions to take when such events occur.
     - ***2.*** ***Release is normally preventable – i.e.*** releases can normally be contained within the site boundary by using BAT such as containment, good practice or odour abatement.
   - ***(b)*** ***For each relevant category, demonstrate that there will not be an odour problem*** from the emissions under normal conditions (see odour guidance).
   - ***(c)*** ***For each relevant category, identify the actions*** to be taken in the event of abnormal events or conditions that might lead to odour, or potential odour problems (see odour guidance**)**.

3. for each relevant category, demonstrate that there will not be an odour problem from the emissions under normal conditions (see odour guidance).

4. for each relevant category, identify the actions to be taken in the event of abnormal events or conditions which might lead to odour, or potential odour problems (see odour guidance).

5. describe the current or proposed position with regard to any techniques in the existing Sector Guidance or in Ref. 24.

Indicative BAT Requirements

1. Guidance on the preparation of an odour plan is given in the separate guidance *Odour Assessment and Control – Guidance for Regulators and Industry* (see Ref. 24) along with information on assessment and control and on dispersion design criteria.

Point source emissions

2. Point source odour emissions may arise from the activities mentioned in Section 2.3.11 and techniques to control odour from these sources should be specified in the responses to Section 2.3.11.

   Although emissions from waste to energy and normal boiler combustion stacks will contain some sulphur compounds (mainly SO_2), they are not usually of sufficient throughput to cause problems.

   Where odorous point sources exist, the frequency of any likely grounding of the plume should be estimated by modelling and appropriate conditions based on frequency or procedures to take (including shutting down where necessary) to minimise the impact of any odorous event (see Ref. 24).

Cont.

Odour

BAT for odour control (cont.)

Fugitive emissions

3. Measures to prevent or reduce fugitive emissions should be supported by a high degree of building containment. This will also include measures such as the maintenance of positive airflows across doorways, extraction to combustion or other abatement systems and the use of fast closing automatic doors, so the odour within the buildings should be contained and fall within category 2 above.

   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 which 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%).
   - High pressure is used to denature proteins and thus affect the activity of enzymes. Usually the process requires flexible packaging that can stand the high pressures of between 50,000 – 100,000 psi. This process has found application in jams, yoghurts and pourable salad dressings.
   - Radio frequency 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.
   - Fugitive odorous sulphur compounds, mercaptans and sulphides are released from anaerobic plant off-gases or anaerobic conditions in water circuits, primary sedimentation or sludge. The microbial action converts sulphites and sulphates, from a wide variety of sources in the water circuit.

4. Odour from waste storage and the effluent treatment plant should, in most cases, be manageable to prevent offensive odours beyond the boundary fence. Covering is a possibility where problems are otherwise intractable.

5. If there are no other sources then there should be no offensive odours beyond the installation boundary. The operator should justify where this situation cannot be attained.

Odour plans, where needed, should be operating within the timescale given in Section 1.1. However, it should be noted that, if there are local problems, the Regulator is likely to require it to be programmed early within the list of work to be carried out by that date.

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

2.4 Emissions to Groundwater

Groundwater protection legislation

The Groundwater Regulations came into force on 1st April 1999 (see Appendix 2 for equivalent legislation in Scotland and Northern Ireland). An IPPC permit will be subject to the following requirements under these Regulations:

i) It shall not be granted at all if it would permit the direct discharge of a list I substance (Regulation 4(1)) (except in limited circumstances - see note 1 below).

ii) If the permit allows the disposal of a List I substance or any other activity which might lead to an indirect discharge (see note 2 below) 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 and in any event conditions to secure 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 Agency's policies in this regard, are outlined in the Agency's document "Policy and Practice for the Protection of Groundwater" (PPPG) (See Ref. 25). This outlines the concepts of vulnerability and risk and the likely acceptability from the Agency's viewpoint of certain activities within groundwater protection zones.

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 Agency 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; the composition and volume of waste to be disposed of; and the rate of planned disposal.

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 Agency where this is being considered as a justification for such discharges.

Note 2 An indirect discharge may be as simple as the use of timber posts impregnated with List I substances.

Note 3 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. They are quoted on the following page.

Application Form Question 2.4

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.

With the Application the operator should:

Meeting the requirements of the Groundwater Regulations

1. confirm that there are no direct or indirect emissions to groundwater of List I or List II substances from the installation, or

2. where there are such releases, provide the information and surveillance arrangements described in A and B above.

Under these Regulations the permit may not be granted if the situation is not satisfactory, therefore, with the application, the operator should supply information on list I and list II substances and if necessary, prior investigation and surveillance information:

Cont.

Groundwater

List I and List II substances in the Groundwater Regulations

List I

1.-(1) Subject to sub-paragraph (2) 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 which may form such compounds in the aquatic environment;
- (b) organophosphorus compounds;
- (c) organotin compounds;
- (d) substances which possess carcinogenic, mutagenic or teratogenic properties in or via the aquatic environment (including substances which have those properties which would otherwise be in list II);
- (e) mercury and its compounds;
- (f) cadmium and its compounds;
- (g) mineral oils and hydrocarbons;
- (h) cyanides.

2. A substance is not in list I if it has been determined by the Agency to be inappropriate to list I on the basis of a low risk of toxicity, persistence and bioaccumulation.

List II

1.-(1) A substance is in list II if it could have a harmful effect on groundwater and it belongs to one of the 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 which have a deleterious 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 which 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 nitrites

(2) A substance is also in list II 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 Agency to be inappropriate to list I under paragraph 1(2); and

(c) it has been determined by the Agency to be appropriate to list II having regard to toxicity, persistence and bioaccumulation.

3.-(1) The Secretary of State may review any decision of the Agency in relation to the exercise of its powers under paragraph 1(2) or 2 (2).

3.-(2) The Secretary of State shall notify the Agency of his decision following a review under sub-paragraph (1) above and it shall be the duty of the Agency to give effect to that decision.

4.- The Agency 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.

Within this sector the most likely List I substances are mineral oils in general use as machine lubricants and biocides from source crops. Other than biocides associated with source crops, List II substances are likely to arise from auxiliary chemical use typically associated with cleaning e.g. other biocides, phosphorus and ammonia.

2.5 Waste Handling

The normal nature and source of the waste from each activity is given in Section 2.3 and will be confirmed in detail in the operator's response to Section 3.1. 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 wasteage, for example, stored product which may have defrosted;
- boiler plant ash (some of which may be special waste);
- effluent plant sludge
- packaging.

Application Form Question 2.5

Characterise and quantify each waste stream and describe the proposed measures for waste management storage and handling.

With the Application the operator should:

1. identify and quantify the waste streams;
2. identify the current or proposed handling arrangements;
3. describe the current or proposed position with regard to the techniques below or any others which are pertinent to the installation;
4. demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the Guide to Applicants) or alternative measures.

Indicative BAT Requirements

General techniques for quantification, storage and handling

BAT for waste handling

1. A system should be maintained to record the quantity, nature, origin and where relevant, the destination, frequency of collection, mode of transport and treatment method of any waste which is disposed of or recovered.
2. Wherever practicable, waste should be segregated and the disposal route identified which should be as close to the point of production as possible.
3. Records should be maintained of any waste sent off-site (Duty of Care).
4. Storage areas should be located away from watercourses and sensitive boundaries e.g. adjacent to areas of public use and protected against vandalism.
5. Storage areas should be clearly marked and signed and containers should be clearly labelled.
6. The maximum storage capacity of storage areas should be stated and not exceeded. The maximum storage period for containers should be specified.
7. Appropriate storage facilities should be provided for special requirements such as for substances that are flammable, sensitive to heat or light etc., and incompatible waste types should be kept separate.
8. Containers should be stored with lids, caps and valves secured and in place. This also applies to emptied containers.
9. Storage containers, drums etc. should be regularly inspected.
10. Procedures should be in place to deal with damaged or leaking containers.
11. All appropriate steps to prevent emissions (e.g. liquids, dust, VOCs and odour) from storage or handling should be taken (see Sections 2.3.11, 2.3.12, 2.3.13 and 2.3.15.

Cont.

BAT for waste handling (cont.)

Techniques specific to this sector

12. 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.

For existing activities, the above techniques should be programmed for implementation within the timescale given in Section 1.1 and the operator should implement any further agreed measures to a timescale agreed with the Regulator.

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.

In order to meet this requirement the Regulator needs operators to provide the information below.

Application Form Question 2.6

Describe how each waste stream is proposed to be recovered or disposed of; and 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.

With the Application the operator should:

1. describe, in respect of each waste stream produced by the installation, whether the waste in question is to be recovered or disposed of, and if a disposal option is planned, to justify why recovery is "technically and economically impossible" together with "the measures planned to avoid or reduce any impact on the environment";

2. include in the description, the operator's view as to whether waste disposal is likely to be restricted by the implementation of the Landfill Directive;

3. describe the current or proposed position with regard to the techniques below or any others which are pertinent to the installation;

4. demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the Guide to Applicants) or alternative measures;

Indicative BAT Requirements

BAT for waste recovery or disposal

1. Unless agreed with the Regulator to be inappropriate, the operator should provide a detailed assessment identifying the best environmental options for waste disposal. For existing activities, this may be carried out 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;

2. 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;

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

   - 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;

Cont.

BAT for waste recovery or disposal (cont.)

- 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.

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).)

3. 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.

For existing activities, the operator should implement any agreed further measures to a timescale agreed with the Regulator.

2.7 Energy

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

either

- the operator meets the basic energy requirements in sections 2.7.1 and 2.7.2 below and is a participant to a Climate Change Levy Agreement or Trading Agreement with the government

or

- the operator meets the basic energy requirements in sections 2.7.1 and 2.7.2 below and the further sector-specific energy requirements in section 2.7.3 below.

Note that even where a Climate Change Levy Agreement or Trading Agreement is in place, it does not preclude the consideration of energy efficiency techniques, (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 CHP;
- the most energy intensive abatement leads to the greatest reduction in other emissions.

Further guidance is given in the Energy Efficiency Guidance Note (Ref.15).

2.7.1 Basic energy requirements (1)

Application Form Question 2.7 (part 1)

Provide a breakdown of the energy consumption and generation by source and the associated environmental releases.

The requirements of this section are basic, low cost, energy standards which apply whether or not a Climate Change Levy Agreement is in force for the installation.

With the Application the operator should:

BAT for energy

1. **provide the following Energy consumption information:**

   Energy consumption information should be provided in terms of delivered energy and also converted to primary energy consumption by using the factors provided in Appendix 4 of the Energy Efficiency Guidance Note, or, where applicable, by the use of factors derived from on-site heat and/or power generation, or from direct (non-grid) suppliers. In the latter cases, the applicant shall provide details of such factors. Where energy is exported from the installation, the applicant should also provide this information. An example of the format in which this information should be presented is given in Table 2-5 below. The operator should also supplement this information with energy flow diagrams (e.g. "Sankey" diagrams or energy balances) showing how the energy is used throughout the process.

   (Note that the permit will require this information to be submitted annually)

Table 2-5 - 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)			

2. **provide the following Specific Energy consumption information**

   The operator should define and calculate the specific energy consumption of the activity (or activities) based on primary energy consumption for the products or raw material inputs which most closely match the main purpose or production capacity of the installation. The operator should provide a comparison of Specific Energy Consumption against any relevant benchmarks available for the sector. This information should be submitted annually.

3. **provide associated environmental emissions**

   This is dealt with in the operator's response to Section 3.1.

2.7.2 Basic energy requirements (2)

Application Form Question 2.7 (part 2)

Describe the proposed measures for improvement of energy efficiency.

The requirements of this section are basic, low cost, energy standards which apply whether or not Climate Change Levy Agreement is in force for the installation.

BAT for energy

With the Application the operator should:

1. describe the current or proposed position with regard to the techniques below:
2. provide justifications for not using any of the techniques described;
3. provide an energy efficiency plan which:
   - identifies all techniques relevant to the installation, including those listed in Section 2.7.3;
   - identifies the extent to which these have been employed;
   - prioritises the applicable techniques according to the appraisal method provided in the Energy Efficiency Guidance Note which includes advice on appropriate discount rates, plant life etc.;
   - identifies any techniques that could lead to other adverse environmental impacts, thereby requiring further assessment (e.g. according to methodology, see Ref. 5).

   Where other appraisal methodologies have been used, state the method, and provide evidence that appropriate discount rates, asset life and expenditure (£/t) criteria have been employed.

   This should be submitted in a summary format similar to the example below (Table 2-6), together with supporting information from any appraisal procedure carried out. The plan is required to ensure that the operator has considered all relevant techniques. **However, where a Climate Change Levy Agreement is in place the Regulator will only enforce implementation of those measures in categories 1-3 above**.

Table 2.6 - Example Format for Energy Efficiency Measures

Energy efficiency option	NPV £k	CO_2 savings (tonnes)		NPV/CO_2 saved £/tonne	Priority* for implementation
		annual	lifetime		
7MW CHP plant	1,372	13,500	135,000	10	high
High efficiency motor	0.5	2	14	35	medium
Compressed air	n/a	5	n/a	n/a	immediate

* Indicative only, based on cost/benefit appraisal:

Where a CCLA is in place, the Energy Efficiency Plan should be submitted 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.

Indicative BAT Requirements

BAT for energy

1. ***Operating, maintenance and housekeeping measures*** should be in place, according to the checklists provided in Appendix 3 of the Energy Efficiency Guidance Note, in the following areas as applicable:
   - 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 maintenance e.g. optimising excess air;
   - other maintenance relevant to the activities within the installation.
2. ***Basic, low cost, physical techniques*** should be in place to avoid gross inefficiencies; to include insulation, containment methods, (e.g. seals and self-closing doors) and avoidance of unnecessary discharge of heated water or air (e.g. by fitting simple control systems).

Cont.

3. ***Building services*** energy efficiency techniques should be in place to deliver the requirements of the Building Services Section of the Energy Efficiency Guidance Note. For energy-intensive industries these issues may be of minor impact and should not distract effort ***from*** the major energy issues. They should nonetheless find a place in the programme, particularly where they constitute more than 5% of the total energy consumption.

4. ***Energy management techniques*** should be in place, according to the requirements of Section 2.1 noting, in particular, the need for monitoring of energy flows and targeting of areas for reductions.

2.7.3 Sector specific energy requirements

Application Form
Question 2.7 (part 3)

Describe the proposed measures for improvement of energy efficiency……(only where the installation is not the subject of a Climate Change Levy Agreement).

Where there is no Climate Change Levy Agreement in place, the operator should demonstrate the degree to which the further energy efficiency measures identified in the implementation plan, including those below, have been taken into consideration for this sector and justify where they have not.

With the Application the operator should:

1. identify which of the measures below are applicable to the activities, and include them in the appraisal for the energy efficiency plan in section 2.7.2.

2. describe the current or proposed position with regard to the techniques below, or any others which are pertinent to the installation;

3. demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the Guide to Applicants) or alternative measures;

Indicative BAT Requirements

BAT for energy

The following techniques should be implemented where they meet the financial criteria in Appendix 4 of the Energy Efficiency Guidance note (Ref. 15).

1. ***Specific Energy Consumption***

   The operator should define and calculate the specific energy consumption of the activity (or activities) based on primary energy consumption for the products or raw material inputs which most closely match the main purpose or production capacity of the installation. The operator should provide a comparison of Specific Energy Consumption against any relevant benchmarks available for the sector. This information should be submitted annually.

2. ***Energy efficiency techniques***

   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, pasteurises and sterilises, where a plate heat exchanger heat has a regeneration capacity up to 94%;
     - in-tunnel and tray ovens, heat exchangers should be fitted to the exhaust flues to remove heat from exhaust gasses 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;

Cont.

BAT for energy (cont.)

- using spent cooling water (which is raised in temperature) in order to recover the heat;
- belt conveying instead of pneumatic(although this must be balanced against higher potential for fugitive releases;
- scheduling of production to optimise continuous processing instead of batch.

In considering these techniques, the operator should assess the impact on the quantity of rejects as well as energy consumption. This is therefore a BAT trade-off decision which may need to be carried out irrespective of any national agreements.

- optimised efficiency measures for combustion plant e.g. air/feedwater preheating, excess air etc

3. ***Energy supply techniques***

Where the optimum proposals are primarily for energy efficiency reasons (such as implementation of gas powered CHP where gas is already the current energy source), the timing will be determined by the Climate Change Levy Agreement. The operator should, in such cases, simply provide a very brief description of the proposals and timing.

Irrespective of whether a Climate Change Levy Agreement is in place, where there are other BAT considerations involved, such as:

- the choice of fuel impacts upon emissions other than carbon e.g. sulphur in fuel;
- the potential minimisation of waste emissions by recovery of energy from waste conflicts with energy efficiency requirements;
- the operator should provide justification that the proposed or current situation represents BAT.

4. The operator should demonstrate that the option for combined heat and power (CHP) generation has been considered and should justify any decision to install a non-CHP option. Where CHP is not appropriate, the preferred fuel, from an environmental point of view, is natural gas. Reasons why this option may not be applicable are the unavailability of gas, the energy balance across the site, that the installation is too small for the available gas turbines or that the projected life of the plant is too short. If there is no foreseeable reason to suspect closure within 7-10 years then this would not be applicable.

5. Where there is an on-site combustion plant other guidance is also relevant. For plants greater than 50MW, operators should consult the IPPC guidance on power generation (reference S2 1.01 and supplement S31.01) and the 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. For incineration plant S2.501 Waste Incineration should be consulted.

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

2.8 Accidents and their Consequences

Guidance

IPPC requires as a general principle that necessary measures should be taken to prevent accidents which may have environmental consequences, and to limit those consequences. This section covers general areas of any installation operations which have the potential for accidental emission.

The typical environmental risks associated with the sectors are the potential for spillage of high organic strength liquids from leaks, spillages or the overfilling of vessels often compounded by 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.

The Control of Major Accident Hazards Regulations 1999 (COMAH) (see Appendix 2 for equivalent legislation in Scotland and Northern Ireland) regime applies to major hazards. For accident aspects covered by COMAH, reference should be made to any reports already held by the Regulator. However, the accident provisions under IPPC may fall beneath the threshold for major accident classification under COMAH and therefore consideration should be given to smaller accidents and incidents as well. Guidance, (see Ref. 20). prepared in support of the COMAH Regulations may also be of help to IPPC operators (whether or not they are covered by the COMAH regime) in considering ways to reduce the risks and consequences of accident.

General management requirements are covered in Section 2.1. 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 occur.

The obvious threshold re COMAH is where an installation is storing over 50 tonnes of ammonia for refrigerant purposes. If an installation is subject to COMAH, there is an element of overlap between IPPC and COMAH and it is recognised that some systems and information for both regimes may be interchangeable.

Application Form Question 2.8

Describe your documented system proposed to be used to identify, assess and minimise the environmental risks and hazards of accidents and their consequences.

With the Application the operator should:

1. describe the current or proposed position with regard to the techniques below or any others which are pertinent to the installation;

2. demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the Guide to Applicants) or alternative measures;

3. identify any issues which may be critical.

Indicative BAT Requirements

BAT for control of accidents

1. A structured accident management plan should be submitted to the Regulator within the timescale given in Section 1.1; which should:

   a. ***identify the hazards*** to the environment posed by the installation. Particular areas to consider may include, but should not be limited to, the following:
   - transfer of substances (e.g. loading or unloading from or to vessels);
   - cleaning (see section 2.3.10);
   - storage of fuel and ancillary chemicals;
   - overfilling of vessels;
   - failure of plant and/or equipment (e.g. over-pressure of vessels and pipework, blocked drains);

Cont.

- failure of containment (e.g. bund and/or overfilling of drainage sumps);
- failure to contain firewaters;
- making the wrong connections in drains or other systems;
- preventing incompatible substances coming into contact;
- unwanted reactions and/or runaway reactions;
- emission of an effluent before adequate checking of its composition has taken place;
- steam main issues;
- vandalism.

BAT for control of accidents (cont.)

b. ***Assess the risks*** - having identified the hazards, the process of assessing the risks can be viewed as addressing six basic questions:

1. what is the estimated probability of their occurrence? (Source frequency);
2. what gets out and how much? (Risk evaluation of the event);
3. where does it get to? (Predictions for the emission – what are the pathways and receptors?);
4. what are the consequences? (Consequence assessment – the effects on the receptors);
5. what are the overall risks? (Determination of the overall risk and its significance to the environment);
6. what can prevent or reduce the risk? (Risk management – measures to prevent accidents and/or reduce their environmental consequences).

The depth and type of assessment will depend on the characteristics of the installation and its location. The main factors which should be taken 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 or otherwise of the activities and the relative difficulty in deciding and justifying the adequacy of the risk control techniques.

c. ***identify the techniques necessary to reduce the risks including:***

c1. the following techniques, which are relevant to most installations:

- an inventory should be maintained of substances, present or likely to be present, which could have environmental consequences if they escape. It should not be forgotten that many apparently innocuous substances can be environmentally damaging if they escape (e.g. a tanker of milk spilled into a watercourse could destroy its ecosystem). The Permit will require the Regulator to be notified of any changes to the inventory;
- procedures should be in place for checking raw materials and wastes to ensure compatibility with other substances with which they may accidentally come into contact;
- adequate storage arrangements for raw materials, products and wastes should be provided;
- to ensure that control is maintained in emergency situations, consideration should be given to process design alarms, trips and other control aspects, e.g. automatic systems based on microprocessor control and passing valve control, tank level readings such as ultrasonic gauges, high-level warnings and process interlocks and process parameters;
- preventative techniques, such as suitable barriers to prevent damage to equipment from the movement of vehicles, should be included as appropriate;
- appropriate containment should be provided, e.g. bunds and catchpots, building containment;
- containment should also be designed to facilitate the collection of any spilled material, for example the use of gradients (hollows) and kerbs;
- techniques and procedures should be implemented to prevent overfilling of storage tanks (liquid or powder), e.g. level measurement, independent high-level alarms, high-level cut-off, and batch metering;
- installation security systems to prevent unauthorised access should be provided as appropriate and should include maintenance arrangements where necessary;
- there should be an installation log/diary to record all incidents, near-misses, changes to procedures, abnormal events and findings of maintenance inspections;

Cont.

- procedures should be established to identify, respond to and learn from such incidents;
- the roles and responsibilities of personnel involved in accident management should be identified;
- clear guidance should be available on how each accident scenario should be managed, e.g. containment or dispersion, to extinguish fires or let them burn;
- procedures should be in place to avoid incidents occurring as a result of poor communication among operations staff during shift changes and maintenance or other engineering work;
- safe shutdown procedures should be in place.
- communication routes should be established with relevant authorities and emergency services both before and in the event of an accident. Post-accident procedures should include the assessment of harm caused and steps needed to redress this.
- appropriate control techniques should be in place to limit the consequences of an accident, such as oil spillage equipment, isolation of drains, alerting of relevant authorities and evacuation procedures;
- personnel training requirements should be identified and provided;
- the systems for the prevention of fugitive emissions are generally relevant (Sections 2.3.13 and 2.3.14) 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 sensor with 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 etc. should not be routinely used as the primary method of level control;

c2. the following plus any other specific techniques identified as necessary to minimise the risks as identified in 1 and 2 above

- adequate redundancy or standby plant should be provided with maintenance and testing to the same standards as the main plant;
- process waters, site drainage waters, emergency firewater, chemically contaminated waters and spillages of chemicals should, where appropriate, be contained and where necessary, routed to the effluent system, with provision to contain surges and storm-water flows, and treated before emission to controlled waters or sewer. Sufficient storage should be provided to ensure that this could be achieved. There should also be spill contingency procedures to minimise the risk of accidental emission of raw materials, products and waste materials and to prevent their entry into water. Any emergency firewater collection system should also take account of the additional firewater flows or fire-fighting foams. Emergency storage lagoons may be needed to prevent contaminated firewater reaching controlled waters (see Refs. 16 and 17);
- consideration should be given to the possibility of containment or abatement for 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;

Sector specific techniques

c3. The following techniques are sector specific:

- ensuring that gross FOG does block drains;
- interlocking of 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, and supply copies with the application, procedures which minimise the risks such as bulking or other breakdown of the wastewater treatment plant and which deal with these events if they occur, including reducing load if necessary;
- provision of adequate effluent buffer storage to prevent spills reaching the ETP or controlled water.

2. For existing activities:

- ***c1*** techniques above should be programmed for implementation within the timescale given in Section 1.1.***c2 and c3*** techniques above should be implemented to a timescale agreed with the Regulator.

2.9 Noise and Vibration

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

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 which 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.

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.

The noise and/or vibration related limits and conditions to be imposed will be determined by the Agency in discussion with both the Local Authority and the operator in accordance with the joint Memorandum of Understanding and the guidance "*Assessment and Control of Environmental Noise and Vibration from Industrial Activities*", (see Ref. 21) and with due regard for any local noise-reduction initiatives.

Application Form Question 2.9	***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.***

With the Application the operator should:

1. provide the following information for ***each main source of noise and vibration*** that fall within the IPPC installation:
   - the source and its location on a scaled plan of the site;
   - whether continuous/ intermittent, fixed or mobile;
   - the hours of operation;
   - its description, (e.g. clatter, whine, hiss, screech, hum, bangs, clicks, thumps or tonal elements);
   - its contribution to overall site noise emission (categorise each as high, medium or low unless supporting data is available).

   A common sense approach needs to be adopted in determining which sources to include. The ones which need to be considered are those which may have environmental nuisance impact; e.g. a small unit could cause an occupational noise issue in an enclosed space but would be unlikely to cause an environmental issue. Conversely a large unit or a number of smaller units enclosed within a building could, for example, cause a nuisance if doors are left open. It must also be remembered that noise, which is not particularly noticeable during the day, may become more noticeable at night.
2. provide the information required in (1) for each source plus its times of operation. For ***Infrequent sources of noise and vibration,*** not listed above that fall within the IPPC installation: (such as infrequently operated/ seasonal operations, cleaning/maintenance activities, on-site deliveries/collections/transport or out-of-hours activities, emergency generators or pumps and alarm testing),
3. identify ***the nearest noise-sensitive sites*** (typically dwellings, parkland and open spaces – schools, hospitals and commercial premises may be, depending upon the activities undertaken there) and any other points/boundary where conditions have been applied by Local Authority officers or as part of a planning consent, relating to:

   (a) the local environment:
   - provide an accurate map or scaled plan showing grid reference, nature of the receiving site, distance and direction from site boundary;

Cont.

(b) conditions/limits imposed which relate to other locations (i.e. boundary fence or surrogate for nearest sensitive receptor):
- any planning conditions imposed by the Local Authority (day/evening/night*);
- other conditions imposed by agreements, e.g. limits on operating times, technologies etc;
- any requirements of any legal notices etc.

(c) the noise environment:
- background noise level, if known (day/night/evening) $L_{A,90,T}$;
- specific noise level (day/evening/night) $L_{A\,eq,T}$; and/or
- ambient noise level (day/evening/night) $L_{A\,eq,T}$, as appropriate;
- vibration data which may be expressed in terms of the peak particle velocity (ppv) in mm s^{-1} or the vibration dose value (VDV) in m $s^{-1.75}$.

For noise these are given the meaning as defined in BS4142:1997 "Method for rating industrial noise affecting mixed residential and industrial areas", and to which reference should be made for a full description. For vibration, the appropriate standard is BS6472:1992 "Evaluation of human exposure to vibration in buildings1 to 80 Hz". In very general terms "background" is taken to be the equivalent continuous A-weighted noise remaining when the source under investigation is not operation averaged over a representative time period, T. The "ambient" level is the equivalent continuous A-weighted combination of all noise sources far and distant, including the source under investigation and "specific noise" is the equivalent continuous A-weighted noise level produced by the source under investigation as measured at a selected assessment point. Both are averaged over a time period, T. BS4142 gives advice on the appropriate reference periods. "Worst case" situations and impulsive or tonal noise should be accounted for separately and not "averaged out" over the measurement period.

4. provide ***details of any environmental noise measurement surveys,*** modelling or any other noise measurements undertaken relevant to the environmental impact of the site, identifying:
   - the purpose/context of the survey;
   - the locations where measurements were taken;
   - the source(s) investigated or identified;
   - the outcomes.

5. identify any specific local issues and proposals for improvements.

6. describe the current or proposed position with regard to the techniques below, any in Ref. 21 or any others which are pertinent to the installation

7. demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the Guide to Applicants) or alternative measures;

Indicative BAT Requirements

BAT for control of noise and vibration

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 (e.g. maintenance of bearings, air handling plant, the building fabric as well as specific noise attenuation measures associated with plant, equipment or machinery).

2. In addition the operator should 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 ($L_{Aeq,T}$) from the installation exceed the numerical value of the Background Sound Level ($L_{A90,T}$), or the absolute levels of 50dB L_{Aeq} by day or 45 by night are exceeded. Reasons why these levels may be exceeded in certain circumstances are given in Ref. 21.

3. In some circumstances "creeping background" see Ref. 21 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 to be appropriate to minimise problems of to an acceptable level within the BAT criteria.

4. Where noise could potentially be a problem, the operator should maintain a Noise Management Plan. For more information see Ref. 21. Noise surveys, measurement, investigation or modelling may be necessary for either new or existing installations depending upon the potential for noise problems.

Cont.

5. Noise surveys, measurement, investigation or modelling may be necessary for either new or existing installations depending upon the potential for noise problems.

BAT for control of noise and vibration (cont.)

Noise control techniques

6. The operator should describe the techniques taken, or proposed, to control noise from the activities including consideration of, but not limited to, those in the above references and those referred to below. The likely impact of these measures on the background levels in the locality and on the noise sensitive locations in particular should be given; with indication of the likely cost and implementation timescale.

7. Siting and location should be used for new plant, but where this is insufficient to meet local needs silencing should be used. For fans this is likely to be broad band absorptive silencing whereas reactive silencing, e.g. pipe resonators, may be more appropriate for vacuum pump noise which is more likely to have specific peak frequencies. A combination of techniques may be needed to achieve particularly low levels. The main cross-media issue is energy, but where the noise is likely to cause nuisance, the energy demands are unlikely to be significant.

8. Primary control is via acoustic hooding and the design of machine hall building structure. There is also considerable noise from the ancillary equipment because of the high transport rates of water, air and solid materials.

9. All of these are best controlled by local hooding (mainly for personnel protection) and building design. All such plant should preferably be indoors with particular attention to acoustic building design, minimising openings and ensuring that doors have automatic closing.

Boiler plant

10. Safety relief valves are the main concern and for new plants over 50 MW(t) silencers should be fitted. However, other sources of noise such as fans and waste or fuel feeding systems should be considered. Gas turbine noise is normally controlled by acoustic cladding, acoustic air intakes and stack attenuators.

Internal transport

11. Within the curtilages of the site the transport of raw materials and finished products are technically associated activities. The most important consideration is roadway layout to minimise the need for reversing and preferably so it takes place in an area where the buildings shield it from current, or potential future, noise sensitive locations.

    If problems persist traffic movement times will need to be limited.

    Once off the site, transport is a planning issue.

General

12. For new plant and for existing plant, where there is a limit to the amount of structural redesign possible, sensitive areas should be shielded by earth banks and plantations.

    Noise abatement can be expensive, especially where retrofitted. Studies have shown that for external attenuation there is a sharp increase in the cost per dB attenuated in this sector below 65 dB(A). See Ref. 21 for guidance on balancing costs and benefits in this area.

For existing activities, the above techniques, where needed, should be operating within the timescale given in Section 1.1. However, it should be noted that, if there are local problems, the Regulator is likely to require it to be programmed early within the list of work to be carried out by that date.

2.10 Monitoring

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

Application Form Question 2.10

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

With the Application the operator should:

1. describe the current or proposed position with regard to the monitoring requirements below or any others which are pertinent to the installation for "Emissions monitoring", "Environmental monitoring", "Process monitoring" (where environmentally relevant) and "Monitoring standards" employed;
2. provide, in particular, the information described in requirement 15 below;
3. provide justifications for not using any of the monitoring requirements described;
4. Identify shortfalls in the above information which the operator believes require longer term studies to establish.

Emissions monitoring

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.

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

Where monitoring shows that substances are not emitted in significant quantities, consideration can be given to a reduced monitoring frequency.

1. Monitoring of process effluents released to watercourses include at least:

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

NB - other parameters specifically limited in the permit should be monitored. The appropriateness of the above frequencies will vary depending upon the sensitivity of the receiving water and should be proportionate to the scale of the operations.

Cont.

Emmisions monitoring (cont.)

2. Monitoring of process effluents released to sewer should include at least:

Parameter	Monitoring frequency
Flow rate	Continuous and integrated daily flow rate
pH	Continuous
Temperature	Dependant on process. If process may generate an effluent > 25°C continuous monitoring would be appropriate.
COD/BOD	Flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages
TOC	Dependant on process. See Monitoring of Process Variables.

***NB** – In addition to monitoring an emission, these (and other parameters which may be specified in the permit) should be used to monitor for example product wasteage . The appropriateness of the above frequencies will vary depending upon the activity and should be proportionate to the scale of the operations.*

3. In addition, the operator should 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. This should normally be done at least annually.
4. 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.

5. In some sectors there may be releases of substances which are more difficult to measure and whose capacity for harm is uncertain, particularly when in combination with other substances. “Whole effluent toxicity” monitoring techniques can therefore be appropriate to provide direct measurements of harm, e.g. direct toxicity assessment. Some guidance on toxicity testing is available (Ref. 22) and the Regulator will be providing further guidance in due course. Except in special circumstances toxicity testing should await that guidance.

Monitoring and reporting of emissions to air

6. 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:

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
VOC from for example; peeling, extrusion, blanching, evaporators, dryers and solvent extraction	Quarterly
Combustion emissions	See separate Guidance

See Section 3, Emission Benchmarks, for guidance on the appropriate levels.

7. Continuous monitoring would be expected where the releases are significant and where it is needed to maintain good control;

8. Gas flow should be measured, or otherwise determined, to relate concentrations to mass releases;

Cont.

Emissions monitoring (cont.)

9. To relate measurements to reference conditions, the following will need to be determined and recorded:
   - temperature and pressure;
   - oxygen, where the emissions are the result of a combustion process;
   - water vapour content, where the emissions are the result of a combustion process or any other wet gas stream. It would not be needed where the water vapour content is unable to exceed 3% v/v or where the measuring technique measures the other pollutants without removing the water.

10. 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.

Monitoring and reporting of waste emissions

11. For waste emissions the following should be monitored and recorded:
   - volume and mass;
   - disposal routes;
   - the physical and chemical composition of the waste;
   - its hazard characteristics;
   - handling precautions and substances with which it cannot be mixed;
   - where waste is disposed of directly to land, for example sludge spreading or an on-site landfill, a programme of monitoring should be established that takes into account the materials, potential contaminants and potential pathways from the land to groundwater surface water or the food chain.

Environmental monitoring (beyond the installation)

Environmental monitoring

12. 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.

    Environmental monitoring may be required, e.g. when:
   - there are vulnerable receptors;
   - the emissions are a significant contributor to an Environmental Quality Standard (EQS) which may be at risk;
   - the operator is looking for departures from standards based on lack of effect on the environment;
   - to validate modelling work.
   - for food and drink installations discharging to controlled waters environmental monitoring programmes are usually needed.

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.

Where environmental monitoring is needed the following should be considered:

- 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;

cont.

- reporting procedures, data storage, interpretation and review of results, reporting format for the provision of information for the Agency.

Guidance on air quality monitoring strategies and methodologies can be found in Technical Guidance Notes M8 and M9 (Ref. 22), for noise (Ref. 21) and odour (Ref. 24).

Environmental monitoring requirements which may be appropriate for this sector:

To water:

- visual monitoring for foaming, colour and visible local effects on the ecology (typically daily);
- upstream and downstream watercourse sampling for nutrients, BOD, COD, specific contaminants or toxicity (regularly to establish conditions and then diminishing if effects constant and acceptable);
- ecology surveys as required to establish the longer term effects on the aqueous environment. These are usually ongoing exercises structured to take account of both the sensitive receptors in the local environment and the changes which occur naturally in that environment in terms of growth, reproduction, etc. of populations of organisms as well the general health of the water course in terms of eutrophication, weed growth, sewage fungus formation, etc.

To air:

- It is anticipated that only larger (>?MW) boiler plant may have sufficient impact on local air quality to require specific air quality management programmes;
- daily visual monitoring to air for smoke, dust, litter, plumes and daily olfactory odour monitoring, with more extensive monitoring if nuisance is occurring or appears likely, see Ref. 24.

To land:

Monitoring surveys will need to be established where sludge is reused for agricultural benefit or ecological improvement or where sensitive soil systems or terrestrial ecosystems are at risk from indirect emission via the air.

To groundwater:

Groundwater sampling may be needed where:

- there is uncertainty about drainage systems, especially on older sites;
- there are deliberate discharges to groundwater;
- there are any other deposits to land.

Noise:

See Section 2.9, and Reference 21 – Noise Regulation and Control.

Monitoring process variables

Monitoring of process variables

13. The following process variables have potential environmental impact and should be considered in this sector. The operator should confirm that this is so or justify any alternative arrangements.

Process variable	Comment	Monitoring Frequency
Product loss or wasteage	See section 2.2.2.1 Monitoring of parameters such as TOC on emissions to sewer can be used to monitor these process variables.	activity specific
Fresh water use across the installation and at individual points of use	See section 2.2.3	normally continuous and recorded
Energy consumption across the installation and at individual points of us		normally continuous and recorded
Refrigerants	Quantity of refrigerant and oil added to or removed from the system (see section 2.3.8).	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

Cont.

Monitoring standards (standard reference methods)

Equipment standards

Equipment standards MCERTS

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) and other MCERTS standards are under development to cover manual stack emissions monitoring, portable emissions monitoring equipment, ambient air quality monitors, water monitoring instrumentation, data acquisition and operators' own arrangements such as for installation, calibration and maintenance of monitoring equipment, position of sampling ports and provision of safe access for manual stack monitoring.

14. As far as possible, operators should ensure their monitoring arrangements comply with the requirements of MCERTS, where available, e.g. using certified instruments and equipment, and using a registered stack testing organisation etc. Where the monitoring arrangements are not in accordance with MCERTS requirements the operator should provide justification and describe the monitoring provisions in detail. See Environment Agency Website (Ref 22) for listing of MCERTS equipment

15. The following should be described in the application indicating which monitoring provisions comply with MCERTS requirements or for which 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.

Sampling and analysis standards

Standards for sampling and analysis

BREF: Monitoring REF document in preparation.

16. The analytical methods given in Appendix 1 should be used in this sector. In the event of other substances needing to be monitored, standards should be used in the following order of priority:
    - Comité Européen de Normalisation (CEN).
    - British Standards Institution (BSI).
    - International Standardisation Organisation (ISO).
    - United States Environmental Protection Agency (US EPA).
    - American Society for Testing and Materials (ASTM).
    - Deutches Institute für Normung (DIN).
    - Verein Deutcher Ingenieure (VDI).
    - Association Française de Normalisation (AFNOR).

Further guidance on standards, for monitoring gaseous releases, relevant to IPC/IPPC is given in the Technical Guidance Note 4 (Monitoring) (see Ref. 22). A series of updated Guidance Notes covering this subject is currently in preparation. This guidance specifies manual methods of sampling and analysis which 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.

If in doubt the operator should consult the Agency.

Monitoring timescales

17. The operator should complete any detailed studies required into monitoring needs (see item 4 at the beginning of this monitoring section) 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

18. For existing activities, the above techniques should be programmed for implementation within the same timescale.

2.11 De-commissioning

Application Form Question 2.11

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 of the installation).

With the Application the operator should:

1. supply the site report;
2. describe the current or proposed position with regard to the techniques below or any others which are pertinent to the installation;
3. for existing activities, identify shortfalls in the above information which the operator believes require longer term studies to establish.

Indicative BAT Requirements

BAT for decommissioning

1. **The site report and operations during the IPPC permit**
   The IPPC application requires the preparation of a site report whose purpose, as described in more detail in Refs. 3 and 4 and in *Preparation of a Site Report in a Permit Application (see Ref. 27)* is to provide a point of reference against which later determinations can be made of whether there has been any deterioration of the site and information on the vulnerability of the site.

   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 which 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;

Cont.

- methods of dismantling buildings and other structures, see Ref. 26 which gives guidance on the protection of surface and groundwater at construction and demolition-sites;
- 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.

(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.)

For existing activities, the operator should complete any detailed studies (see Application item 3 above), 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

2.12 Installation-wide Issues

In some cases it is possible that actions which 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.

Application Form Question 2.12

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.

With the Application the operator should:

1. where there are a number of separate Permits for the installation (particularly where there are different operators), **identify** any installation wide issues and opportunities for further interactions between the permit holders whereby the performance of the overall installation may be improved; and in particular

2. describe the current or proposed position with regard to the techniques below, or any others which are pertinent to the installation;

BAT across the whole installation

Indicative BAT Requirements

The possibilities will be both sector and site-specific, and include:

1. communication procedures between the various permit holders; in particular those needed to ensure that the risk of environmental incidents is minimised;

2. benefiting from the economies of scale to justify the installation of a CHP plant;

3. the combining of combustible wastes to justify a combined waste-to-energy/CHP plant;

4. the waste from one activity being a possible feedstock for another;

5. the treated effluent from one activity being of adequate quality to be the raw water feed for another activity;

6. the combining of effluent to justify a combined or upgraded effluent treatment plant;

7. the avoidance of accidents from one activity which may have a detrimental knock-on effect on the neighbouring activity;

8. land contamination from one activity affecting another – or the possibility that one operator owns the land on which the other is situated.

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

3 EMISSION BENCHMARKS

3.1 Emissions Inventory and Benchmark Comparison

Application Form Question 3.1

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

With the Application the operator should:

1. provide a table of significant emissions of substances (except noise, vibration, odour or heat which are covered in their respective sections) that will result from the proposals in Section 2 and should include, preferably in order of significance:
   - substance (where the substance is a mixture e.g. VOCs or COD, separate identification of the main constituents or inclusion of an improvement proposal to identify them);
   - source, including height, location, efflux velocity and total gas or water flow;
   - media to which it is released;
   - any relevant EQS or other obligations;
   - benchmark;
   - proposed emissions normal/max expressed, as appropriate (see Section 3.2), for:
     - mass/unit time,
     - concentration (and total flow),
     - annual mass emissions,
   - statistical basis (average, percentile etc.);
   - notes covering the confidence in the 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 (refer to Sections 2.5 and 2.6 – Waste Management);
   - point source emissions to air;
   - significant fugitive emissions to all media, identifying the proportion of each substance released which is due to fugitives rather than point source releases;
   - abnormal emissions from emergency relief vents, flares etc.;

   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 e.g. 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 Energy Efficiency Guidance Note.

   Where VOCs are released, the main chemical constituents of the emissions should be identified. The assessment of the impact of these chemicals in the environment will be carried out as in response to Section 4.1.

   For waste, emissions relate to any wastes removed from the installation, or disposed of at the installation under the conditions of the Permit, e.g. 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.
2. compare the emissions with the benchmark values given in the remainder of this Section;
3. where the benchmarks are not met, revisit the responses made in Section 2 as appropriate (see Section 1.2) and make proposals for improvements or justify not doing so.

3.2 The 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. They are not mandatory release limits and reference should be made to Section 1 and the Guide for Applicants regarding their use.

The lower figure in the quoted ranges would normally be expected from a new installation. Existing installations should operate to the lowest practicable figure within the range taking into account the BAT criteria, in particular, release limits for water set in the permit will take into account the effect on the receiving water. For example, limits on Total P for a discharge to seawater may not be appropriate since nitrogen, not phosphorus is the more significant nutrient in marine waters.

3.2.1 Standards and obligations

In addition to meeting the requirements of BAT, there are other national and international standards and obligations which 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. The most likely of these to be relevant in this sector are referred to under the appropriate substance. **The extracts from standards are, however, quoted for ease of reference; the relevant and most up to date standards should be consulted for the definitive requirements.**

3.2.2 EC based EQ Standards

IPPC: A Practical Guide (see Ref. 1) 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:

Air Quality

- Statutory Instrument 1989 No 317, Clean Air, The Air Quality Standards Regulations 1989
- Statutory Instrument 1997 No 3043, Environmental Protection, The Air Quality Regulations 1997

Water Quality

- Directive 76/464/EEC on pollution Caused by Dangerous Substances Discharged to Water, contains two lists of substances. List 1 relates to the most dangerous and standards are set out in various Daughter Directives. List 2 substances must also be controlled. Annual mean concentration limits for receiving waters for List 1 substances can be found in SI 1989/2286 and SI 1992/337 the Surface Water (Dangerous Substances Classification) Regulations. Values for List 2 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 and water quality standards are likely to be replaced by new standards in the near future.
- The (Draft) Solvents Directive on the limitation of emissions of VOCs due to the use of organic solvents in certain activities and installations.

Other standards and obligations

- Hazardous Waste Incineration Directive;
- Waste Incineration Directive (Draft)
- Large Combustion Plant Directive
- Reducing Emissions of VOCs and Levels of Ground Level Ozone: a UK Strategy
- 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
- The Montreal Protocol
- The Habitats Directive (see Section 4.3)

3.2.3 Units for benchmarks and setting limits in permits

Releases can be expressed in terms of:

- **"concentration"** (e.g. mg/l or mg/m^3) 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"** (e.g. kg/ $t_{product}$ 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"** (e.g. 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.

3.2.4 Statistical basis for benchmarks and limits in permits

Conditions in permits can be set with percentile, mean or median values over yearly, 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 Agency 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). BREF figures are generally yearly averages.

For Air benchmarks or limits are most frequently expressed as daily averages or, typically 95% of hourly averages. BREF figures are generally yearly averages.

3.2.5 Reference conditions for releases to air

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

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.

3.3 BOD

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)

UK Water Quality Objectives	**BOD (ATU) mg/l 90%ile**	**Dissolved O_2 % 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 O_2 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

Benchmark Emission Values

The BOD benchmarks are obviously important where a treated effluent is being discharged to a watercourse. It is also an important measure where the effluent is to be treated off-site (see section 2.3.14) 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 uprated 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, 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 there is no significant impact.

3.4 COD

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)

	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

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)

	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), 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.

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	

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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 underway which could lead to a requirement further to reduce emissions of NOx.

Waste Incineration Directive (Draft) requires a NOx level of 200 mg/m^3.

Benchmark Emission Values

Media	Activity	Benchmark value		Basis for the Benchmark
		Mass release	Concentration	

To air	from combustion plant		See appropriate guidance note	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).

UK Water Quality Objectives	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

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 **Error! Reference source not found.**) 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 submicron 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:

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 PM_{10}

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

Activity	Benchmark value	Basis for the Benchmark
Fugitive from equipment, plant buildings, storage yards and materials handling (2.3.13)	"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 (2.3.13)	50 mg/m^3	
Point release from combustion plant/incineration	See appropriate guidance note	See appropriate guidance note Based on parity with other sectors

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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 SO_2 emissions *from all sources* has been agreed. The second Sulphur Protocol (Oslo, 1994) obliges the UK to reduce SO_2 emissions by 80% (based on 1980 levels) by 2010.

Benchmark Emission Values

Media	Activity	Benchmark value		Basis for the Benchmark
		Mass release	Concentration	
To air	from combustion plant		See appropriate guidance note	Would include low sulphur fuels or control of sulphur emissions

3.11 VOCs

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 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. Food and Drink 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,

Emission	Activity	Threshold	Benchmark value	Basis for the Benchmark
Solvents (various).	extraction	emission > 5 t/yr	80 mg/m^3 as toluene	Parity with other UK industrial sector benchmarks
VOCs and dioxins	Other combustion /incineration		See appropriate guidance	

4 IMPACT

4.1 Assessment of the Impact of Emissions on the Environment

Application Form Question 4.1

Provide an assessment of the potential significant environmental effects (including transboundary effects) of the foreseeable emissions.

With the Application the operator should:

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 (e.g. 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 (i.e. Habitat Directive sites, special areas of conservation, Sites of Special Scientific Interest (SSSI) or other sensitive areas), soil, water, i.e. groundwater (water below the surface of the ground in the saturation zone and in direct contact with the ground and subsoil) and watercourses (e.g. 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. Ref. 5 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 (Ref. 3) and Section 3.2) with:
   - community EQS levels;
   - other statutory obligations;
   - non-statutory obligations;
   - environmental action levels (EALs) and the other environmental and regulatory parameters defined in Ref. 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.

   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.

   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.

5. 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 The Waste Management Licensing Regulations

Application Form
Question 4.2

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.

In relation to activities involving the disposal or recovery of waste, the Agencies are required to exercise their functions for the purpose of achieving the relevant objectives set out in Schedule 4 of the Waste Management Licensing Regulations 1994. (For the equivalent Regulations in Scotland and Northern Ireland, see Appendix 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 which involve the recovery or disposal of waste. Paragraph 4(1) is as follows:

a) "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:

i risk to water, air, soil, plants or animals; or

ii causing nuisance through noise or odours; or

iii adversely affecting the countryside or places of special interest.

b) Implementing, as far as material, any plan made under the plan-making provisions."

The application of BAT is likely already to 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 you 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, such as sites of special scientific interest (SSSIs) which could be affected, 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.

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).

4.3 The Habitats Regulations

Application Form
Question 4.3

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 purposes of the Conservation (Natural Habitats etc) Regulations 1994 (SI 1994/2716).

Your response should cover all relevant issues pertinent to your installation, including those below. In doing so you should justify your proposals against any indicative requirements stated.

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.

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 SAC 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 also be considered to be European sites for the purposes of Regulation 10.

Information on the location of European Sites and their conservation objectives is available from

- English Nature (01733 455000), http://www.english-nature.org.uk
- Countryside Council for Wales (01248 385620), http://www.ccw.gov.uk
- Scottish Natural Heritage (0131 447 4784) http://www.snh.org.uk
- Joint Nature Conservation Committee (01733 866852), http://www.jncc.gov.uk

The Agency will need to consider the operator's initial assessment and if it concludes that the installation is likely to have a significant effect on a European site, then the Agency will need to carry out an "appropriate assessment" of the implications of the installation in view of that site's conservation objectives. Because the Regulations impose a duty on the Agency to carry out these assessments, it cannot rely on the operator's initial assessments, and therefore the Agency must be provided with any relevant information upon which the operator's assessment is based.

Note that in many cases, the impact of the Habitats Regulations will have been considered at the planning application stage, in which case the Agency should be advised of the details.

REFERENCES

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

1. The Pollution Prevention and Control Act (1999) (www.uk-legislation.hmso.gov.uk).
2. The Pollution Prevention and Control Regulations (SI 1973 2000) (www.uk-legislation.hmso.gov.uk).
3. IPPC: A Practical Guide (for England and Wales) (or equivalents in Scotland and Northern Ireland) (www.environment.detr.gov.uk).
4. IPPC Part A(1) Installations: Guide for Applicants – EA publication.
5. Assessment methodologies.
    - E1 BPEO Assessment Methodology for IPC
    - IPPC Environmental Assessments for BAT (in preparation as H1).
6. Waste minimisation references:
    - Environment Agency Website. Waste minimisation information accessible via: www.environment-agency.gov.uk/epns/waste;
    - ETBPP, Cost-Effective Membrane Technologies for Minimising Wastes and Effluents, GG54;
    - ETBPP GG157, 1999
    - ETBPP GC150 Turning Waste into Profit: A Good Practice Case Study at Joseph Heler
    - **Waste Minimisation** - *an environmental good practice guide for industry* (help 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 the ETBPP and the BOC Foundation. (A software tool designed for small and medium businesses.). Available free from The Environmental Helpline, Tel 0800 585794;
    - Environmental Technology Best Practice Programme - ETBPP- a Joint DTI/DETR 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. The ETBPP is accessible via a FREE and confidential **helpline Tel. 0800 585794** or via the website: www.etsu.com/etbpp/
    - Waste Management Information Bureau. The UK's national referral centre for help on the full range of waste management issues; the bureau produces a database called Waste Info, which is available for Online searching and on CD-ROM. *Short enquiries are **free:** enquiry line 01235 463162;*
    - Institution of Chemical Engineers Training Package E07 - Waste Minimisation. Basic course. Contains Guide, Video, Slides, OHPs etc. Available from Tel 01788 578214.
7. Water efficiency references:
    - ETBPP, Cost Effective Water Saving Devices and Practices GG67;
    - ETBPP Tracking Water Use to Cut Costs GG152;
    - ETBPP, Simple measures restrict water costs, GC22;
    - ETBPP, Saving money through waste minimisation: Reducing water use, GG26;
    - ETBPP Helpline 0800 585794.
8. Main Activities references:
    - 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, GG 154.
9. Environment Agency (1998) Optimum use of water for industry and agriculture dependent on direct abstraction: Best practice manual. R&D technical report W157, WRc Dissemination Centre, Swindon (tel 01793 865012)
10. Air Abatement references:
    - A3 Pollution abatement technology for particulate and trace gas removal 1994 £5.00. 0-11-752983-4 (EA website - summary).
11. Water Treatment references:
    - A4 Effluent Treatment Techniques, TGN A4, Environment Agency, ISBN 0-11-310127-9 (EA website - summary);
    - Wehrle Environmental, Spinners Court, 53 West End, Witney, Oxfordshire, OX8 6NJ;

- Pollution Control in the Treatment and Processing of Animal and Vegetable Matter, DoE/HMIP/RR/93/058;
- ETBPP, Effluent costs eliminated by water treatment, GC24;
- ETBPP, Cost Effective Separation Technologies for Minimising Wastes and Effluents, GG37;
- ETBPP, Cost Effective Membrane Technologies for Minimising Wastes and Effluents, GG54;
- ETBPP, Membrane Technology Turns Effluent into Cost Savings NC259;

12. Environment Agency, Pollution Prevention Guidance note – Above ground oil storage tanks, PPG 2 gives information on tanks and bunding which have general relevance beyond just oil. (EA website)
13. Mason, P. A. Amies, H. J, Sangarapillai, G. Rose, Construction of bunds for oil storage tanks, 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 online purchase).
14. Dispersion Methodology Guide D1 (EA Website)
15. Energy References:
    - IPPC Energy Efficiency Guidance Note (the consultation version, available on the website should be used until the final version is published)
    - Energy Efficiency Best Practice Programme (EEBPP) publications (Helpline 0800 585794);
    - IPC S2 1.01 Combustion processes: large boilers and furnaces 50MW(th) and over November 1995, £9.95 ISBN 0-11-753206-1;
    - IPC S3 1.01 Combustion Processes supplements IPR 1/2, IPC S2 1.01, S2 1.03 to S2 1.05;
    - IPC S2 5.01 Waste incineration - October 1996, £30.00 ISBN 0-11-310117-1.
16. BS 5908: Code of Practice for Fire Precautions in the Chemical and Allied Industries.
17. Environment Agency, Pollution Prevention Guidance Note - Pollution prevention measures for the control of spillages and fire fighting run-off, PPG 18 gives information on sizing firewater containment systems (EA website)
18. Investigation of the criteria for, and guidance on, the landspreading of industrial wastes – final report to the DETR, the Environment Agency and MAFF. May 1998.
19. Agency guidance on the exemption 7 activity, proposed.
20. 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, DETR, 1999, ISBN 753501 X, available from the Stationery Office.
21. Assessment and Control of Environmental Noise and Vibration from Industrial Activities – (Joint agencies guidance in preparation).
22. Monitoring Guidance (EA website):
    - M1 Sampling facility requirements for the monitoring of particulates in gaseous releases to atmosphere March 1993, £5.00 ISBN 0-11-752777-7;
    - M2 Monitoring emissions of pollutants at source January 1994, £10.00 ISBN 0-11-752922-2;
    - 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;
    - MCERTS approved equipment link via http://www.environment-agency.gov.uk "Guidance for Business and Industry" page;
    - Direct Toxicity Assessment for Effluent Control: Technical Guidance (2000), UKWIR 00/TX/02/07.
23. The Categorisation of Volatile Organic Compounds. DOE Research Report No DOE/HMIP/RR/95/009 (EA website).
24. Odour Assessment and Control – Guidance for Regulators and Industry. (Joint agencies guidance in preparation).
25. "Policy and Practice for the Protection of Groundwater" (PPPG) (EA website).
26. Working at Construction and Demolition-sites (PPG 6) (EA website).
27. IPPC - Preparation of a Site Report in a Permit Application (EA website)

DEFINITIONS

BAT	Best Available Techniques
BAT Criteria	The criteria to be taken into account when assessing BAT, given in Schedule 2 of the PPC Regulations
Biocides	Pesticides, Herbicides and Fungicides
BOD	Biochemical Oxygen Demand
CHP	Combined heat and power plant
COD	Chemical Oxygen Demand
DAF	Dissolved air flotation
EMS	Environmental Management System
ETP	Effluent treatment plant
ITEQ	International Toxicity Equivalents
NIEHS	Northern Ireland Environment and Heritage Service
SECp	Specific Energy Consumption
SEPA	Scottish Environment Protection Agency
SS	Suspended solids
STW	Sewage treatment works
TOC	Total Organic Carbon
TSS	Total Suspended Solids
VOC	Volatile organic compounds and includes all organic compounds released to air in the gas phase.

APPENDIX 1 - SOME COMMON MONITORING AND SAMPLING METHODS

Table A1.1: 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
BOD_5	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 ISNB 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
Pentachloro-Phenol				BS5666 Part 6 1983 – Wood preservative and treated timber quantitative analysis of wood preservatives containing pentachlorophenol
Formaldehyde				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 A1.2: 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 Triphenyltin (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 A1.3: 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 Ref 22.

APPENDIX 2 - EQUIVALENT LEGISLATION IN SCOTLAND & NORTHERN IRELAND

The legislation referred to in the text is that for England and Wales. The following are the equivalents for Scotland and Northern Ireland.

Table A.2.1 - Equivalent Legislation

England and Wales	*Scotland*	*Northern Ireland*
PPC Regulations (England and Wales) SI 2000 1973	PPC (Scotland) Regulations 2000; SI 200/323	
The Water Resources Act 1991	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 1989/317: Clean Air, The Air Quality Standards Regulations 1989	The Air Quality Standards Regulations (Northern Ireland) 1990. Statutory Rules of Northern Ireland 1990 No 145
SI 1997 No 3043: Environmental Protection, The Air Quality Regulations 1997	SSI 2000/97 The Air Quality (Scotland) Regs	No NI equivalent
SI 1989 No 2286 and 1998 No 389 the Surface Water (Dangerous Substances Classification) Regulations. (Values for List 2 substances are contained in SI 1997/2560 and SI 1998/389)	SI 1990/126 Surface Water (Dangerous Substances) (Classification) (Scotland) Regs	Surface Waters (Dangerous Substances) (Classification) Regulations 1998. Statutory Rules of Northern Ireland 1998 No 397 SI1991/1597:
SI 1991/1597: Bathing Waters (Classification) Regs	SI 1991/1609 Bathing Waters (Classification) (Scotland) Regs	The Quality of Bathing Water Regulations (NI) 1993
SI 1992/1331 and Direction 1997 Surface Waters (Fishlife) (Classification) Regs	SI 1997/2471 Surface Waters (Fishlife) (Classification) Regs	The Surface Water (Fishlife) (Classification) Regulations (NI) 1997
SI1997/1332 Surface Waters (Shellfish) (Classification) Regs	SI 1997/2470 Surface Waters (Shellfish) (Classification) Regs	The Surface Water (Shellfish) (Classification) Regulations (NI) 1997
SI1994/2716 Conservation (Natural Habitats etc) Regulations 1994	SI 1994/2716 Conservation (Natural Habitats etc) Regs	Conservation (Natural Habitats etc) Regulations (Northern Ireland) 1995
Control of Major Accident Hazards Regulations 1999 (COMAH)	SI 1999/743 Control of Major Accident Hazards Regs	Control of Major Accident Hazard Regulations (Northern Ireland) 2000 for NI