Technical Guidance Note

IPPC S6.01

Integrated Pollution Prevention and Control (IPPC)

Technical Guidance for the Pulp and Paper Sector

ENVIRONMENT AND HERITAGE SERVICE

SEPA

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Record of changes

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Consultation	May 2000	
1	1 Aug 2000	Initial version for use available on the website only, little changed from consultation version.
2	7 Nov 2000	Revisions take into account the consultation comments and also restyling for publication. Timescales clarified to show what is needed with application and what can, if agreed, be dealt with after the permit is issued.

Note:

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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 Agency" or "the Agencies" 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

This UK Guidance for delivering the PPC (IPPC) Regulations in the Pulp and Paper sector is based on the BAT Reference document BREF (see Ref. 1) produced by the European Commission. The BREF is the result of an exchange of information between member states and industry. The quality, comprehensiveness and usefulness of the BREF is acknowledged. This guidance is designed to complement the BREF and is cross-referenced to it throughout. It takes into account the information contained in the BREF and 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 reader is advised to have access to the BREF.

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 very brief description of the activities (referring to the BREF for more detail) to assist the reader to understand the context of the requirements;
- provide a summary of the BAT techniques for pollution control from the BREF 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. mechanical pulping or effluent treatment) (Sections 2.3 - 2.4);
  - particular emissions (e.g. NOx or pesticides) (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 EHS web sites (see References).

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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 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. Indicative standards <u>are</u> laid out in national guidance (such as this) for each sector and should be applied unless there is strong justification for another course of action. However, justifications for departures from those standards, in either direction, can be made at the local level 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 takes into account the information contained in the BREF and lays down the indicative standards and expectations in the UK. At this national level, techniques 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.

Assessing BAT at the installation level

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 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 the sector may be to change to a different design of furnace when a furnace comes up for rebuild). 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 Agencies 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. Indicative upgrading timescales are given for existing activities

Existing installations

For an existing activity a less strict proposal or an extended timescale may, for example, be acceptable where the activity operates to a standard that is very close to an indicative requirement, but using different plant or processes from that upon which the indicative requirement is based. In such a case it may impose a disproportionate cost to replace the old plant with the new techniques for only a small decrease in emissions. Equally, local environmental impacts may require action to be taken more quickly than the indicative timescales given in this Guidance. Furthermore, where IPC upgrading programs are already in place, it is not expected that the indicative timescales given in this Guidance would extend these.

All of the requirements identified in the BAT boxes in Sections 2 and 4 should be justified in the application (see also Note 1 in Section 1.2). Where information is not available, the reason should be explained and, preferably, discussed with the Agency before finalising the application. The Agency may require, by formal notice, information that is missing. Information, studies and procedures that are agreed with the Agency to be unrealistic to provide or have in place within the application period should be carried out to an agreed, prioritised programme. The Agencies will expect the operator to provide such information and carry out such work as soon as practicable after the permit is issued to ensure that all aspects are completed during this period. For this Sector, all items should be carried out by 30 June 2004. Items which some operators **may** find difficult to provide with the application are given in the "post application" boxes in Section 2.

Implementation of other measures identified will be to a timescale agreed with the Agency. Such timescales will depend upon the improvement and other local factors and may be earlier or later than the above date.

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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. 4) 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 by this Note

This Note covers installations described in Part A(1) of Section 6.1 of Schedule 1 to the PPC Regulations (see Ref. 2) viz:

Pulp and paper manufacturing activities:

a) i) producing pulp from timber or other fibrous materials,

ii) paper and board with a production capacity exceeding 20 tonnes per day.

b) *Any activity associated wit*h the making of paper pulp or paper, including activities connected with the recycling of paper such as de-inking, not associated with an activity otherwise described in this section if the activity may result in the release into water of any substance described in Schedule 5 in a quantity which, in any 12 month period, exceeds the background quantity by more than the amount specified in relation *to the description of substance in column 2 of that schedule.*

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
- water abstraction and treatment plant
- debarking and chipping
- pulping or repulping
- de-inking
- washing
- bleaching
- stock preparation
- papermaking
- reeling and cutting
- storage and despatch of finished products, waste and other materials
- the control and abatement systems for emissions to all media
- on and off machine coating plants
- the power plant
- a waste to energy plant
- waste handling and recycling facilities

Figures 1-1 to 1-3 show the main operations.

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. Particular examples relevant to pulp and paper installations would be:

- *A site includes a paper mill, a power plant and an effluent treatment plant all operated by different companies.* The installation may include all of these items with each operator separately permitted within the installation. Applications from the operators will be separate but concurrent.
- *Two papermaking companies share a common power plant (dedicated to their use) and a common effluent treatment plant.* The installation would include all of these items with each operator separately permitted within the installation. In this case the installation could cover more than one site.

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 (eg Refs 21)
- 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 and incineration plants.

Figure 1-1 - Summary of the Pulping Techniques

Key

Optional Processes

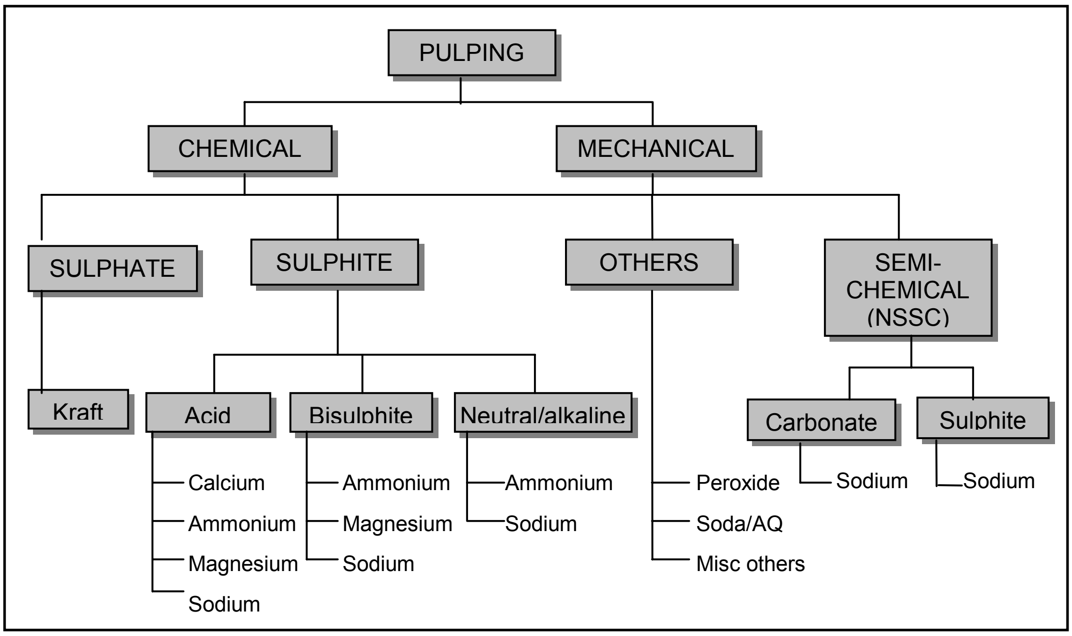


Figure 1-2 - Pulping Activities

Key

Optional Processes

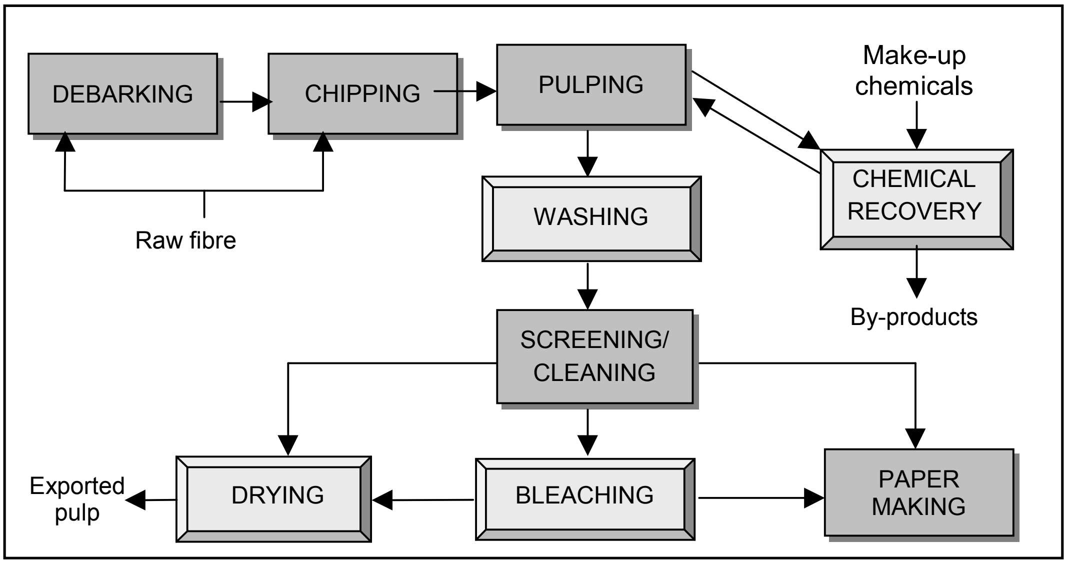
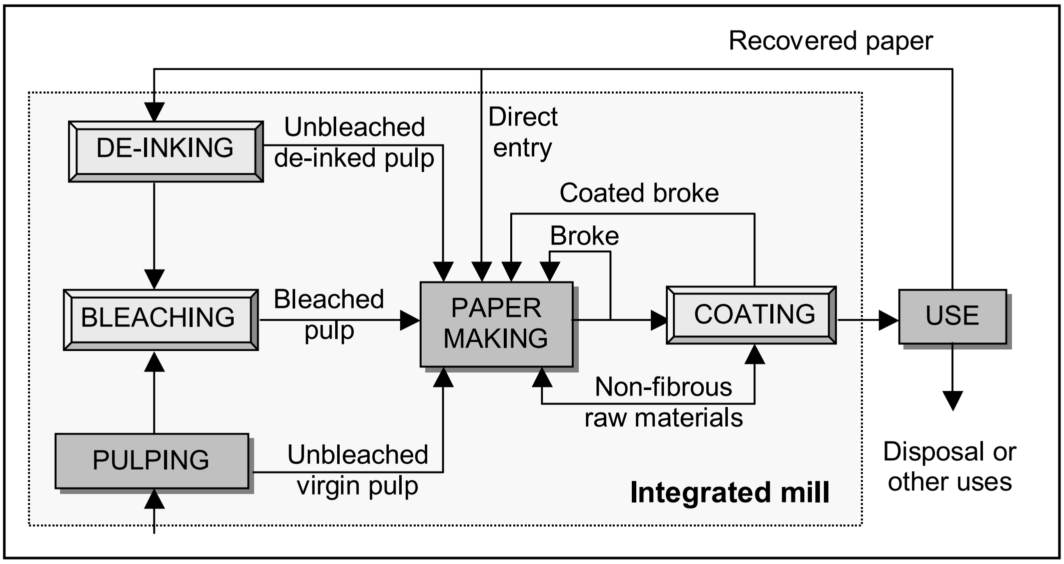


Figure 1-3 - Papermaking Activities

Key

Optional Processes



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 stated in its third consultation paper (England, Wales and Scotland) on the implementation of IPPC, that the new sector-specific IPPC Technical Guidance Notes would provide guidance on appropriate review periods for each sector. These would take into consideration guidance on the relevant criteria, to be provided by the Government. Examples of the likely relevant criteria for setting these review periods are "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 Agencies 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.

The need for updating any of the information, or for completely re-issuing this Guidance, will be assessed:

- prior to the bulk of activities in the above categories in this sector coming up for review;
- following any update of the BREF;
- following technological advances or other advances in knowledge relevant to this sector.

1.5 Key Issues for this Sector

Water efficiency

Water use is a major issue, not so much from the point of view of water conservation, since actual loss to the environment is low, but from the knock-on effects of high water use in terms of increased emissions. A large mill with the best conventional Effluent Treatment Plant (ETP) may still release 2-5 tonnes/day of largely unidentified substances with poor biodegradability (COD) into the watercourse (see Section 2.2.3).

Fibre recovery

An assessment of the recovery of fibre within the process may be needed (see Sections 2.2.3 & 2.3.8).

Bleaching

A major problem has been the use of chlorine compounds in bleaching. This affects both the pulp mills and the paper mills that use their pulp. This is now much reduced by the use of ECF and TCF pulp. There must be a strong justification for using chlorine-bleached pulps (see Section 2.3.7).

Water treatment (BOD)

Most mills discharge via either their own or a municipal treatment works. In either case, confirmation that the more persistent substances are broken down remains an issue and the minimisation of BOD according to BAT criteria is a new requirement (see Sections 2.3.11 and 3.3).

Heat, VOC recovery and visible plume suppression

An assessment of paper machine heat recovery and plume suppression may be needed (see Section 2.3.8).

VOCs from coating, mechanical pulping, bleaching and broke bleaching

The significance will vary considerably between installations (see Sections 2.3.3, 2.3.7, 2.3.8, 2.3.9).

Releases associated with energy use

The industry is a major energy user. There remain significant opportunities for reduction of emissions caused by energy use and choice of energy source (CO_2, SO_x, NO_x, etc. contributing in particular to global warming and acidification). The industry may enter into a Climate Change Levy Agreement with the Government. The applicability of techniques and standards for IPPC is explained in Section 2.7.

Accident risk

Apart from the normal process and spillage risks, many older sites (especially those not regulated under IPC) will have unsecure drainage systems that will need attention (see Section 2.8).

Noise

There are major noise sources on pulp and paper mills that should be addressed (see Section 2.9).

Long distance and transboundary pollution

No pollutants which come into this category are identified for installations in this sector in the UK since there are no Kraft or full sulphite mills. Associated power plants are unlikely to be of sufficient size to have significant transboundary effects.

Monitoring

The residual organic constituents of the effluent are generally not known in detail, so it is hard to monitor. Analysis of the constituents of the effluent will be a key issue and direct toxicity testing may be appropriate (see Section 2.10).

Solid waste recovery, recycling and disposal

Sludge to land is a major issue. The Agencies' policy on this is reflected in this document. An assessment of the options for the recovery or disposal of fibre and filler from sludge is likely to be needed (see Section 2.6).

Site restoration

Many paper mills will have been operating on the same site for many years. There may well be ground contamination that could be confused with potential future contamination from the activities as they will be operated under IPPC. In such cases it will be necessary to assess the degree of contamination as a baseline for future operations.

1.6 Summary of Releases

SOURCE RELEASES To: Air Water Land A W L	Sulphite, without recovery, unbleached	Sulphite or Kraft, with recovery	NSSC sulphite, with recovery	NSSC sulphite, without recovery	Bleaching with chlorine	Bleaching with chlorine dioxide	Bleaching with sodium hypochlorite	TCF bleaching, no recovery	Incoming water treatment	RCF pulping & de-inking	Wood yard (Note 1)	Mechanical pulping	CTMP mechanical pulping, no recovery	Papermaking	Effluent plant (Note 2)
Sulphides, methane & mercaptans	-	AW	AW	-	-	-	-	-	-	-	-	-	-	(AW)	AW
Oxides of sulphur	A	A	A	A	-	-	-	-	-	-	-	-	W	-	-
Oxides of nitrogen & carbon	-	A	A	-	-	-	-	-	-	-	-	-	-	-	A
Particulate/TSS	W	AW	AW	W	W	W	W	W	-	W	W	W	W	W	-
Alcohols, fatty & resin acids	W	W	W	W	-	-	-	-	-	-	W	W	W	W	-
Lignin, lignin degradation products & other wood organics	W	W	W	W	W	W	W	W	-	W	W	W	W	W	-
Cadmium	W	W	W	W	W	W	W	W	-	W	W	W	W	W	-
Mercury	W	W	W	W	W	W	W	W	W	W	W	W	W	W	-
Other heavy metals	W	W	W	W	W	W	W	W	-	W	W	W	W	W	-
Chlorine	-	-	-	-	A	-	-	-	AW	A	-	-	-	-	-
Chloroform & bromoform	-	-	-	-	AW	AW	AW	-	AW	AW	-	-	-	-	AW
Pentachlorophenol	W	W	W	W	W	-	-	-	-	W	-	-	-	W	-
Other biocides	-	-	-	-	-	-	-	-	-	W	-	-	-	W	-
Dioxins & furans and/or PAH	-	A	A	-	W	-	-	-	-	-	-	-	-	-	-
Other chlorinated organics	-	-	-	-	W	W	W	-	-	W	-	-	-	W	-
Fibres & inorganic fillers	W	W	W	W	W	W	W	W	-	W	W	W	W	W	-
Dispersants & surfactants	-	-	-	-	-	-	-	-	-	W	-	-	-	W	-
Coatings, sizes, defoamers, dyes & dye additives, optical brighteners, wet & dry strength agents & dichloropropanol	-	-	-	-	-	-	-	-	-	W	-	-	-	W	-
Formaldehyde	-	-	-	-	-	-	-	-	-	-	-	-	-	AW	-
Phosphates & nitrates	W	W	W	W	-	-	-	-	-	-	-	W	W	W	W
Sulphites & sulphates	W	W	W	W	-	-	-	-	-	W	-	W	W	W	-
Ammonia	-	-	-	-	-	-	-	-	-	-	-	-	-	W	W
Sludges	-	-	-	-	-	-	-	-	-	L	-	-	-	-	L
Bark and wood waste	-	-	-	-	-	-	-	-	-	-	L	-	-	-	-

Notes: 1 Wood yard - assuming dry de-barking.

2 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 2.6).

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

1.7 Overview of the Activities in this Sector

No. of UK Mills	
Papermaking only	60 sites approx.
Papermaking integrated with pulping of virgin fibres	6 sites
Papermaking integrated with de-inking of recovered paper	18 sites
Papermaking integrated with both pulping and de-inking	1 site
Papermaking with on-site coating plants	18 sites
There is also one non-integrated chemical pulp mill	1 site

Summary of the activities

This section provides a very brief description of the pulping and papermaking activities. Further detail can be found in the BREF.

The industry is a large user of water, energy and a range of fibrous raw materials and chemicals with the potential for significant releases to water, air and land.

The biggest pollution potential in this sector is with chemical pulp mills which have significant pollution potential to air, land and water. The UK, however, has only a very few, small, chemical pulp mills. The main activities, for the UK, are paper mills and mechanical and recovered pulp mills.

Stages of making paper and pulp (see Figure 1-1 and Figure 1-2)

Wood and the main non-wood fibres used in papermaking (straw, hemp, etc) are a complex mixture of the same substances - cellulose (40-45%), hemi-celluloses (25-35%), lignin (20-25%) and extractives (5-10%).

- Pulping is the process of converting the virgin fibre into a form suitable for making paper.
- Mechanical cleaning with or without de-inking is the analogous process for cleaning up recovered papers (most recovered paper is recycled without de-inking).
- Bleaching (optional) whitens the pulp either by removing more lignin (for chemical pulps) or by changing its chemical structure (mechanical pulps).
- Papermaking converts the pulped cellulose fibres into paper or board on a paper machine.
- Coating (optional) uses water-based or solvent-based (rarely nowadays) coatings.

Environmental effects of additional unit processes

In the main part, the environmental effects of additional unit processes (e.g. coating, de-inking, pulping, papermaking) being present on a site are simply additive, but there are some examples of interactions:

- the exchange/recycling of waters between the pulping and papermaking sides of integrated mills changes the routing of wastewater components and should be able to reduce fresh water use compared to two separate non-integrated mills,
- the recycling of coated broke at mills with coating operations transfers coating materials into the papermaking system which can change the efficiency of the papermaking process, leading to a deterioration in raw wastewater quality,
- at integrated pulp and paper mills, some of the volatile wood compounds may be released to air from the pulp stream after it reaches the papermaking side of the operation.

Pulping options

Pulping is the process by which the structure of wood or other cellulose-bearing materials, such as straw, grass or hemp, is broken down to separate the individual cellulose fibres. The pulp, comprising fibres which vary from 0.1 to 8 mm in length, forms the raw material for papermaking and is also used in the manufacture of rayon, cellophane and some products in the chemical industry.

Wood has several other constituents besides cellulose, the most important of which are hemicelluloses and lignin. The composition of wood is typically 45% cellulose, 25% lignin, 25% hemicelluloses and 5% other organic and inorganic materials.

In chemical pulping, chemicals are used to dissolve the lignin which surrounds the fibres. The lignin and many other organic substances are thus put into solution and there is a potential for them to be released to water. In mechanical pulping processes mechanical shear forces are used to pull the fibres apart and the majority of the lignin remains with the fibres, although there is still some significant dissolution of organics. Pulps produced in different ways have different properties that make them suited to particular products.

The options are shown in Figures 1-1 to 1-2 For more information see Section 2.3.

Papermaking

A paper mill may reconstitute pulp made elsewhere or may be integrated with the pulping operations on the same site. There are relatively few integrated, virgin pulp mills in the UK. Mill capacities vary from less than 30 to more than 1000 ADt/day. There are many different products produced by the industry which can be broadly categorised as follows:

- ***Newsprint***: mills are usually integrated with RCF or mechanical pulping and are characterised by large size, wide, fast machines, low retention, long runs, few dyes or other chemicals.
- ***Printing and writings***: most printing/writing paper made in the UK is from chemical pulp. They all contain filler and sizing agents and may be uncoated or surface treated with starch and coatings. Dyes and optical brighteners are also used in some grades. Retention aids are needed to minimise loss of filler.
- ***Packaging paper boards***: from high quality card to a range of qualities of cardboard packaging.
- **Packaging papers**
- ***Liner and fluting***: is the base for rigid packing cases. The outer part, or liner, is often made from 100% non-de-inked waste packaging. The middle part of the case (the corrugating or fluting medium) can be made from virgin NSSC pulp or from waste packaging. The use of the latter involves high use of surface starch to give adequate stiffness. The liner is also sized to give water resistance and may also be treated to give some wet strength. No fillers or coatings are used in these grades, although they may be in other packaging products. There are considerable solid trash arisings. Water systems are substantially closed.
- ***Specialist papers***: some of the most specialist papers in the UK are associated with mills which are integrated with chemical pulping. Unlike other integrated mills, the fresh water consumption at this type of small, integrated mill still tends to be very high

Common equipment

There are certain pieces of equipment which are common to a number of the processes, namely:

- ***Hydropulpers***: large vessels fitted with powerful agitators or large rotating drums, which are used for re-pulping fibres back into suspension in water, such as re-pulping bales of imported pulp, wastepaper or broke (paper formed on the machine but not usable for a variety of reasons).
- ***Refiners***: used either for mechanically separating fibre from the wood (see mechanical pulping), or for fibrillating the fibres (see papermaking) by passing them between the faces of grooved and rapidly rotating metal discs or cones.
- ***Thickeners***: there are many stages of cleaning and rinsing the fibres. After each rinse the water is removed with thickeners which are basically drum or disc screens, catching the pulp and letting the water pass. For further de-watering, belt thickeners, wet lap machines (squeezed between rollers), screw presses, hydraulic clamp presses, V plate presses or simple versions of the Fourdrinier paper machine (see papermaking) are used.
- ***Screens, filters and cleaners***: commonly used designs are vibrating screens, pressure screens whose baskets have either slots or holes to handle the fibres, multi-stage centrifugal cleaners and dissolved air flotation methods.

1.8 Economic Aspects

1.8.1 Sector information

Over the last decade or so, the UK industry has expanded largely through the expansion of existing mills, but there have also been some eight new mills constructed on greenfield sites. Pulping and papermaking is a capital-intensive industry and there are economic constraints on existing mills adopting techniques that would represent the best investment at a new mill. Nevertheless, there are many techniques given in Section 2 that can be adopted at relatively low cost and where, for more major improvements, an assessment of the costs and benefits is needed the following information may be of assistance.

1.8.2 Cost information

Activity	Size	Capital (£M)	Operational (£M/y)	Comment
Membrane filtration as a save-all	5000 m^3/d	0.195/m^3	0.091/m^3	Source - BREF Based on ultrafiltration Operational costs include service, maintenance, membrane changes, energy and washing chemicals
Membrane filtration for coating recovery	2 m^3/hour	0.13 - 0.2		Source - BREF Based on ultrafiltration 1-2 yr payback based on saving of coatings, (10-50 t/d)
Membrane filtration for coating recovery	200-400 m^3/d	0.33 - 1.0	0.65	Source - BREF Based on ultrafiltration
Pre-treatment of coating effluent by flocculation	1000 ADt/d	0.8 - 0.9	0.5-1.0 + landfill costs	Source - BREF
Water storage	1000 ADt/d mill two towers 2000 m and 3000 m 2nd broke tower for coated broke	0.65 - 0.8 0.25 - 0.33		Source - BREF
Better machine controls	300 ADt/d mill saving 1 7 min break /week	£0.17 M/yr lost production as well as environmental damage		Source - BREF Payback on equipment typically <1 yr especially on older mills
Primary effluent treatment	1000 ADt/d mill	2.2 - 3	0.25-0.4	Source - BREF Includes pumping, clarifier, sludge dewatering, chemical dosing

2 TECHNIQUES FOR POLLUTION CONTROL

BAT Boxes to help in preparing applications

This Section summarises, in the outlined BAT boxes, the requirements and indicative standards which the operator must address in making an application.

These outlined BAT boxes cover the techniques and measures which 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".

The issues raised in the outlined BAT boxes reflect the questions in the Application Form (see Section 1.2). The boxes are also cross-referenced to the BREF section from where the requirement is to be found.

More details on both the descriptions and BAT will be found in the BREF to which cross-references are extensively given, and both regulatory staff and operators will find it useful to have access to that document.

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. For example, scope for this in this sector would be by substitution of materials or processes. For example, the replacement of coating solvents, harmful dyes, or pulping chemicals with less harmful alternatives (see Section 2.2.1). There is also scope to prevent releases of water altogether in some cases (see Section 2.2.3). 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. An example in this sector is the need to maintain the operation of the ETP during shut down.
- 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.
- Techniques in green text (viewable on electronic versions) are additional to the BREF requirements.

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 Agencies 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.

Operators who do not have an accredited system will be expected to follow the principles set out in this section and provide full and detailed answers to demonstrate how the requirements are met. The steps required in this and subsequent sections could form the basis of an application for accreditation.

Application Form Question 2.1

Provide details of your proposed management techniques.

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.

BAT for management techniques

BREF Sections 4.4.1, 5.4.2, 6.4.2

The operator should have a management system in place for the activities which delivers the requirements given below. The system should be described in detail to demonstrate how it meets the requirements and how it is applied to the “operational issues” below in practice.

Where a company has an Environmental Management System (EMS registered or certified to recognised standards [i.e. EMAS (EC Eco Management and Audit Scheme) (OJ L168, 10.7.93), ISO 14001] a copy of the certificate and a statement confirming that the system delivers all the requirements below (or actions proposed where any aspects are not covered) will be sufficient for the application (NB in Scotland a brief description of how each bullet point is dealt with is required). It should be noted that EMAS accredited systems should normally cover most of the requirements whereas ISO 14000 systems do not automatically cover environmental reporting.

Requirements of a management system:

- Identification of key environmental impacts of the activities.
- Objectives and measurable goals for environmental performance.
- A programme of improvements to implement goals and targets.
- Monitoring on a regular basis of the overall environmental performance of the installation.
- Feedback from the monitoring to the setting of the targets with a commitment to regularly improve the targets where appropriate.
- Regular audit both internal and independent.
- Regular reporting of environmental performance (annual or linked to the audit cycle), both for:
  - submitting an annual environmental report to the Agencies; and
  - (preferably) a public environmental statement.
- Clear allocation of responsibilities for environmental performance, in particular meeting the aspects of the IPPC Permit.
- 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.
- Procedures to analyse faults and prevent their recurrence.

(Cont.)

BAT for management techniques (cont.)

- Provision of adequate procedures and training for all relevant staff, which should include the following specific areas:
  - 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 for operational staff;
  - the nature of the technical expertise required will depend on the activities being carried out. In general terms, however, staff assigned to both technical and managerial posts upon which the installation's compliance depends will need to have sufficient qualifications, training and experience for their roles. This may be assessed against industry sector standards or codes of practice where appropriate.
- Preventative maintenance programmes for relevant plant and equipment.
- Procedures for recording, investigating and taking corrective action in response to environmental complaints and incidents.
- Incorporation of 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.

For further guidance on acceptable performance for each of the above items, (see Ref. 6).

Operational Issues

The operator should show, in practice, how the management system applies to each of the following aspects of the activities:

- Selection of raw materials;
- Water efficiency;
- Waste minimisation;
- Control of point and fugitive emissions;
- Waste management;
- Energy;
- Noise and vibration;
- Prevention of accidents
- Monitoring.
- For specific advice for paper mills see Ref. 6.

With the application, the operator should supply the current or proposed position with regard to all of the above requirements and the proposed upgrading program for any items not adequately covered.

Post application, as described in Section 1.1 for existing installations:

- the development of any aspects of the management system not already in place;

Selection of raw materials

2.2 Materials Inputs

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

(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 should demonstrate the steps that have been, or may be, 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 more readily dealt with. In this sector in particular use those which can be more readily degraded in the effluent treatment plant, wherever possible and use materials that have the optimal retention characteristics and do not inhibit the recycling of recovered paper, see this section and Section 2.3.8;

Understand

- **understand** the fate of by-products and contaminants 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 chemicals used will end up as a waste or in the final effluent, even if much reduced by treatment. In the aquatic environment, even where evidence suggests little acute toxicity to man or other species, there is usually little knowledge regarding chronic or synergistic effects. Because of the wide variety of chemicals used there will always be a risk of harmful effects that may not be expected or immediately apparent. A good example of this has been where the combination of resin acids from some UK paper mills, in specific combination with petroleum products from other industries, has led to pigmented salmon syndrome.

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.

BREF Table 4.1, see also 4.2 and 4.3

2.2.1.1 Raw materials used in mechanical pulping

Wood - softwoods, most commonly spruce at a rate of 1.08 - 1.03 tonnes of debarked wood/tonne pulp.

BREF Tables are not applicable to UK mills

2.2.1.2 Raw materials used in chemical pulping

Cellulose: (all woods), hemp or grasses.

Chemicals for pulping of non-wood fibres are, most commonly:

- sodium hydroxide in the soda process;
- sodium hydroxide and sulphite in the alkaline sulphite process.

The quantity of make-up chemicals depends on the efficiency of chemical recovery where this practised, but is less than 5% of the total quantities required in the Kraft process.

Chemicals for pulping of wood fibres - see Table A3.1 in Appendix 3.

BREF Annex 1

2.2.1.3 Raw materials used in de-inking

Recovered paper: newspapers and magazines for newsprint and office-type papers for tissue/printing paper manufacture

Chemicals: to assist in the removal of undesirable constituents from the recovered paper (see Table A3.2 in Appendix 3) which all end up either in the de-inked pulp or in the waste streams.

BREF Annex 1

2.2.1.4 Raw materials used in bleaching chemical pulps

See Table A3.3 in Appendix 3.

2.2.1.5 Raw materials used in bleaching mechanical pulps

See Table A3.4 in Appendix 3.

BREF Section 4.1.3

The oxidative bleach hydrogen peroxide (dose up to 30 kg/tonne pulp). This is used under alkaline conditions provided by caustic soda (15 kg/t) or sodium silicate (15 kg/t) plus added chelant (normally DTPA 3 kg/t) to complex interfering metal ions.

Selection of raw materials

The reductive bleach sodium hydrosulphite/dithionite (dose up to 10 kg/tonne pulp). This is used under slightly acidic conditions (pH 5.5-6.5), again with added chelant.

BREF Table 5.5, 5.6 & Sections 5.2.2.1- 5.2.2.4

2.2.1.6 Raw materials used in bleaching recovered fibre de-inked pulps

See Table A3.2 in Appendix 3.

2.2.1.7 Raw materials used in coating

BREF Table 6.2

The vast majority of these operations are purely aqueous with no organic solvents present. However, some specialised coating operations do use solvents such as isopropanol (release papers) or high boiling point hydrocarbons like di-isopropyl-naphthalene (carbonless copy papers).

The pigment makes up the majority of the solids in the aqueous coating mixture and the main coating pigments are the same as the main wet end fillers, namely kaolin clay and calcium carbonate. They are used in a dispersed slurry form (70-75% solids content) to which the other coating materials are blended. In order to form a strong, cohesive and adhesive layer on the paper, the pigment is held together by binders, which are predominantly synthetic latices based on styrene-butadienes, polyvinylacrylates, etc. Other binders are natural products such as starches, carboxymethylcellulose (CMC) and casein. A variety of other additives are incorporated to control foam and as rheology/viscosity modifiers, lubricants, dispersants, dyes, brighteners and cross-linkers. The overall coating mix is applied at 30-70% solids content.

2.2.1.8 Raw materials used in papermaking

BREF Table 6.4

The choice of fibre and the blend of other additives depend on the type of paper and other factors. These characteristics are summarised in Tables A3.4 and A3.5 in Appendix 3 for the main grades of paper and board made in the UK.

Fibre: varies from virtually 100% of some products (e.g. newsprint), but can be as low as 50% in some coated papers. The sources are:

- virgin fibre (wood, straw, hemp) pulped on-site or as bought-in pulp;
- recovered paper (may be de-inked or cleaned mechanically).

BREF Tables 6.2, 6.3 and Annex 1

Chemicals: see Table A3.6 in Appendix 3.

Product additives e.g. fillers for opacity, sizes for water resistance, starches for dry strength, resins for wet strength, dyes for colour, etc. Additives are sub-divided into those added to the fibrous suspension before the paper web is formed (the wet end) and those added later to the web surface.

Process additives used to control different aspects (usually problems) within the papermaking system, e.g. biocides for slime control, defoamers, coagulants/flocculants for retention and drainage, etc. They are used in varying proportions by most mills irrespective of the paper grade being made.

The general papermaking properties and environmental characteristics of the non-fibrous raw materials are summarised in Table A3.5 in Appendix 3. The critical characteristic for all wet end materials is their retention in the web judged in relation to the mass of that material entering the system (total retention) or the mass present on the paper machine (first or single pass retention). The total retention is important in relation to efficiency/losses and product quality and the single pass retention in relation to machine runnability and some aspects of product quality. All materials should have the highest possible single pass retention, but this depends on many factors such as particle size, machine speed, product grammage, etc. The total retention depends on the single pass retention plus the degree of water closure. Materials added to the surface of the paper web have close to 100% retention at the point of addition, but may be lost when broke is re-pulped.

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.

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.

BAT for selection of raw materials

BREF Sections: 5.4.2, 6.3.12, 6.4.2, & Annex 1

While the operator would be expected to maintain a detailed inventory of raw materials used on-site, a list of the materials used, which have the potential for significant environmental impact, should be supplied with the application. This list should include:

- 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 the existing technical guidance (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 which could have a significant effect of the environment is included. Product data sheets should be available on-site.

The operator should justify, in the application, (e.g. on the basis of impact on product quality), the continued use of any substance for which there is a less hazardous alternative.

The operator should have procedures by which the awareness of new developments and their implications will be achieved.

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

Raw material	Selection techniques
Timber, wood chips, hemp	• Timber, wood chips, hemp etc. should not have been sprayed with harmful substances, e.g. lindane and pentachlorophenol (PCP).
Bought-in pulps	• Only ECF or TCF grades should be used. **(#)** • If chlorine bleached pulps are justified in the short term, levels of chlorinated organics (particularly dioxins/furans and the higher chlorinated phenolics, e.g. PCP) should be measured and reported. • The contribution of pulps to other significant environmental aspects, such as wastewater COD or toxicity, should be quantified and reported. **(#)**
Recovered paper	• The content and routing of harmful substances (e.g. cadmium and other heavy metals and PCP) should be quantified and reported. **(#)**
Filler	• Provided that it is compatible with the paper specification, calcium carbonate would normally be preferred to clay due to the higher and more consistent overall retentions achievable. The operator should describe how retention is maximised and wastewater residues minimised.
Wet strength agents UF/MF	• The lowest free formaldehyde content resins should be used (available at <0.5%). **(#)**
Wet strength agents PAE	• Resins with lowest practicable content of chlorinated organic by-products, notably dichloropropanol should be used. **(#)**
Optical brighteners	• The most retentive type should be used, preferably added at the size press. **(#).** The operator should bear in mind the relative solubility of wet end versus size press brighteners and the dissolution of the latter on broke repulping.
Fuels	• See Section 2.7.3

Cont.

Selection of raw materials

BAT for selection of raw materials (cont)

See BREF Sections: 5.4.2, 6.3.12, 6.4.2, & Annex 1

Raw material	Selection techniques
Fresh water disinfectants	• Use should be minimised commensurate with effective control of micro-organisms. • For high organic loads, ClO_2 or equivalent should be used instead of halogenated disinfectants
Retention aids	• The system should be optimised for wire retentions and the retentions quantified.
Deposit/scale control chemicals	• To reduce chemical addition, deposits should first be minimised by a combination of raw material selection, maximising retention, regular machine cleaning and effective showering systems, avoiding high rates of pH or temperature change. Minimum impact chemicals should be selected.
Dispersants/ surfactants	• Only chemicals with high biodegradability and known degradation products should be used. • Alkylphenolethoxylates should be avoided. **(#)**
Process biocides	• Biocide use should be minimised by other complementary techniques such as regular system cleaning and the need to minimise generation not only of slime, but also of undesirable substances (e.g. organic acids and sulphides) within water circuits. • Preferentially, biocidal agents (e.g. guanidine and isothiazolones) with rapid degradation and with known degradation products should be used.
Chemicals for bleaching pulp and broke	• Elemental chlorine should not be used. **(#)** • Any use of sodium hypochlorite for decolorising broke or repulping wet strengthened papers in relation to alternative TCF techniques should be justified. • Where chlorine-containing bleaches are justifiably used; the emissions of relevant chlorinated organics (e.g. chloroform, PCP) are quantified and minimised and residual chlorine in the pulp neutralised. **(#)**
Chelants	• DTPA should be used in preference to EDTA or NTA because of its superior degradability(#)
Defoamers	• Only fully biodegradable products with known, safe degradation products should be used.
Solvents	• Wherever possible, coatings using organic solvents should be replaced by aqueous versions. (#)
Dyes and auxiliary chemicals in dye formulations	• Dyes and auxiliary chemicals that are not either biodegradable or inorganic should be identified and their use justified. • Dyes with solid pigments should only be used where they can be abated by clarification. • Dyes that are non-bleachable in broke/recovered paper, particularly those that are non-bleachable in TCF processes, should be identified and their use justified.
NaOH	• Only "low mercury" NaOH should be used. **(#)**

With **the application**, the operator should supply:

- the list of principal raw materials with available information on fate, impact and alternatives;
- the current or proposed position with regard to any alternatives above;
- identification of shortfalls in information or justifications for not using available alternatives;

Post application, as described in Section 1.1, for existing installations:

- the detailed site inventory of raw materials and the procedures for awareness of new developments and quality assurance;
- any studies resulting from the shortfalls in data with regard to environmental impact of raw materials and alternatives or justifications where further studies are needed;
- substitutions as agreed with the Agency with priority given to those marked with (#) in the above list.

Use of raw materials

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;
- 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.

Application Form Question 2.2 (part 2)

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

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.

BAT for minimisation

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 reactants, intermediates, by-products, solvents and other support materials such as inerting agents, fuels, catalysts and abatement agents, should be mapped onto a process flow diagram (see Ref. 7) 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.

References (see Ref. 7) provide detailed information, guides and case studies on waste minimisation techniques. Section 2.3 covers cleaner technologies and waste minimisation opportunities specific to the main activities in this sector.

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

Post application, as described in Section 1.1:

- for both new and existing installations, a comprehensive waste minimisation audit;
- Implementation of the measures identified and longer-term studies should take place to a timescale agreed with the Agency

Water use

2.2.3 Water use

Summary of the activities

Water is predominantly used for transportation of the wood and pulp. There is a high degree of recycling benefiting particularly from the integration of other activities with papermaking. A further motivation for recycling is to conserve process temperatures; sometimes operators will deliberately wastewater in order to maintain lower temperatures.

2.2.3.1 Water circuits for mechanical pulping

BREF Section 4.2.2.2

The water circuits can be seen in Figure 2-1 as follows:

Local recycling loop: the water enters prior to the refiner/grinder, transports the pulp through screening, cleaning and thickening. The filtrate from thickening is returned to the refiner/grinder.

Recycling loop from the paper machine: the water, which continues with the pulp to the paper machine, is eventually recycled as paper machine whitewater to the make-up to the refiner/grinders.

2.2.3.2 Water circuits for chemical pulping and bleaching

BREF n/a to UK mills

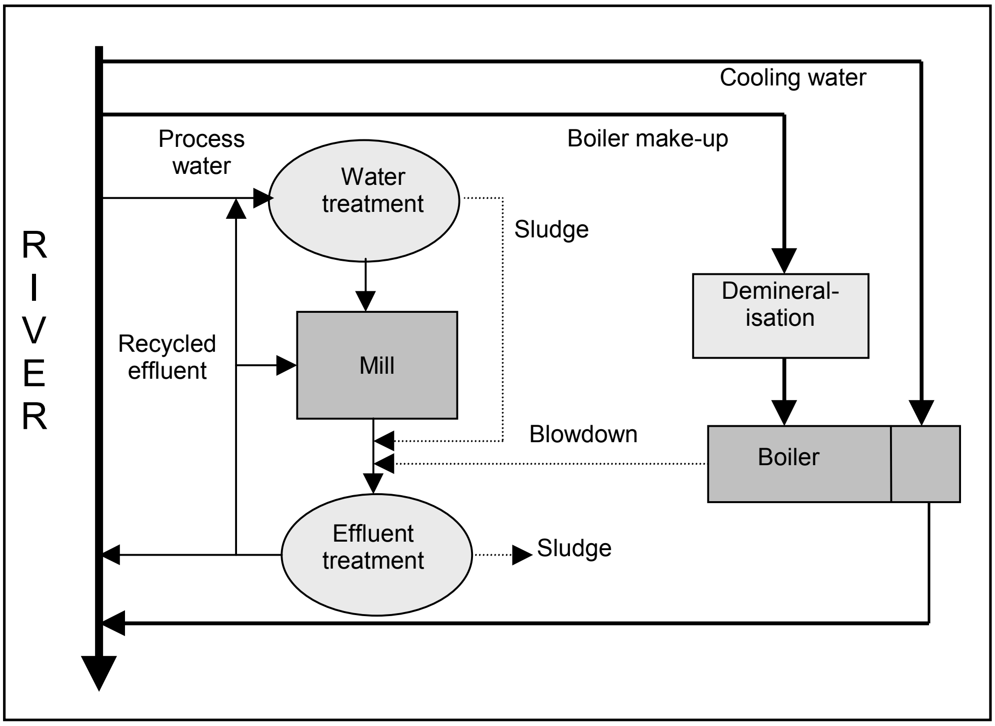
Use can be as high as 100 m^3/tonne pulp or more, particularly at older, bleached mills, and this is still not uncommon at non-wood mills where there is no liquor burning and chemical recovery (typical in the UK). In particular at such small non-wood pulp mills, bleaching may only involve two or three stages sometimes using simple, but inefficient, drum washers/thickeners leading to very high flows of bleaching wastewater.

2.2.3.3 Water circuits for de-inking

BREF Section 5.2.2.2

Water is normally supplied from the papermaking machine to the latter stages of the de-inking process and then recycled, counter-current, through the stages. Water from an integrated system would leave the circuit with the scum from the flotation cell and with the cleanings and screenings, i.e. from the dirtiest part of the circuit. The remainder of the water passes forward again, with the pulp, to the paper machine.

Figure 2-1 - General Pattern of Water Use



Water use

Summary of the activities

BREF Section 6.2.2.2

2.2.3.4 Water circuits for papermaking

A general pattern of overall water use at paper mills is shown in Figure 2.2. The uses of water in papermaking can be broken down into the following three categories:

1. Transportation medium and solvent

This is the largest water flow, and is greatest at the wet end of the machine (from about 100 to several 1000 m^3/ADt depending on the grade being made).

Most of this water is recycled within the primary (short) and secondary (long) recirculation loops, so the fresh water use should be small. Water from the later part of the formation wire and the press fabrics is extracted by vacuum. On some paper machines, there is a save-all within the secondary loop to recover non-retained fibre and generate clarified water. Save-alls are most commonly filtration devices (e.g. disc filters), but flotation cells are also used.

Backwater tanks provide storage to accommodate the inevitable imbalance between the generation of backwater and its requirement for stock dilution.

2. Cleaning and washing

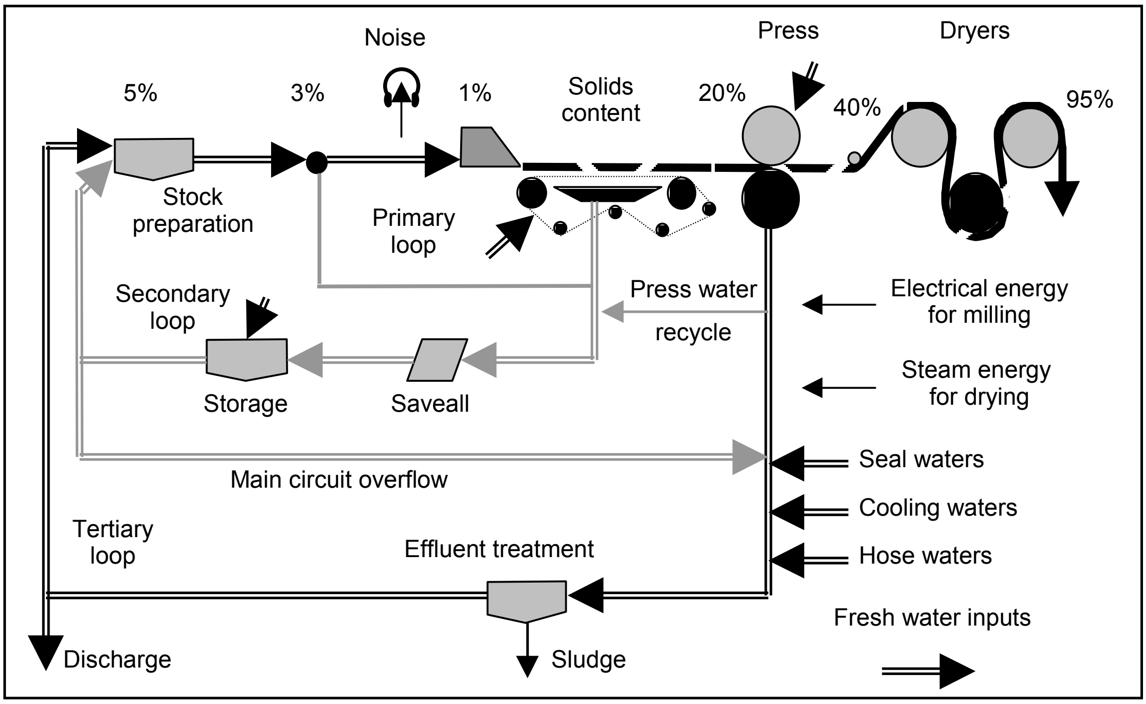
Fibre and other materials must be continuously or intermittently cleaned from paper machine surfaces (particularly the formation wires and the press section fabrics and their support rolls) using a variety of showering devices. Some of this water needs to be clean but it should be cleaned recycled water wherever possible. Hoses for cleaning are ubiquitous at most paper mills, but should be controlled by pistol-grips and supplied with suitable recycled, not fresh, water.

3. Sealing and cooling

Mainly for vacuum pumps, up to 10 m^3/tonne, however, this is usually recycled (e.g. as clarified whitewater). Alternatively a partially or fully closed dedicated loop can be used. The latter will require internal cooling and screening to maintain quality. Water-free vacuum pumps are also used by some mills.

Smaller quantities of water (1-2 m^3/tonne) are required for sealing rotating shafts (e.g. pumps or refiners) and this tends to be fresh water. Alternatively, shafts can be sealed with compounds not requiring flushing water or with mechanical seals. Other equipment (e.g. winders) requires small volumes of water for cooling, but this uncontaminated water can be recovered for general re-use.

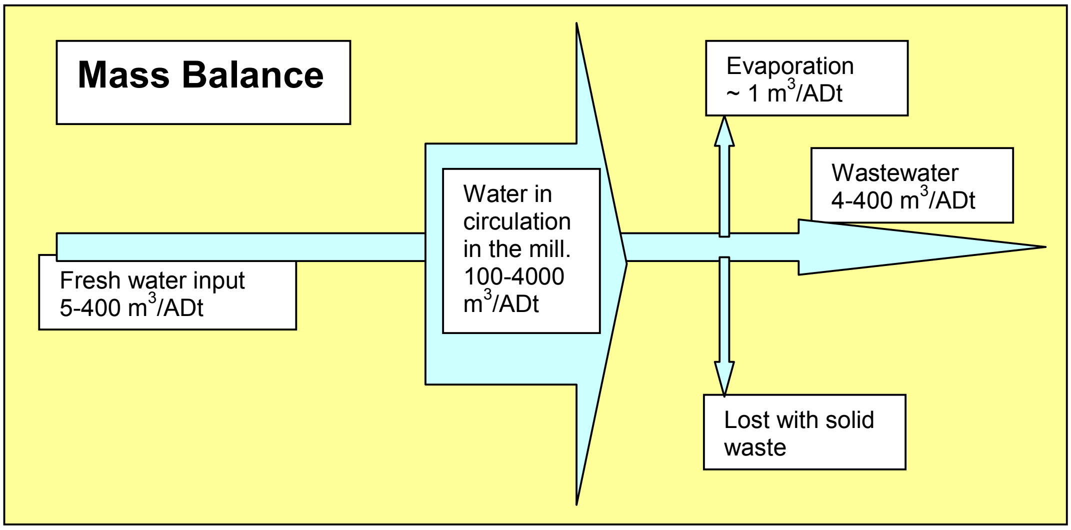
Figure 2-2 - Process Water System in Papermaking



Water use

2.2.3.5 Why consider water efficiency and what are the problems?

Figure 2-3 - Water Mass Balance



Philosophy of water closure

It can be seen from the mass balance (Figure 2.3) that most of the water input is returned to the local water environment. Thus, if water use is the aim in itself (perhaps because of local supply constraints), then the only ways to affect it are by minimising the relatively small losses to air and land.

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 both:

- ***closing the water circuit*** (thereby increasing the concentrations in the circuit) because:
  - the higher concentrations reduce the dissolution of solubles from the pulp/timber;
  - the higher concentrations improve retention of solubles into the paper web (at water closures below 15 m3/ADt);
  - this results in savings in raw material costs as well as lower loads on the ETP;
  - less solid waste (sludge) generated as a by-product of wastewater treatment;
  - the efficiency of the water treatment plant is increased at higher concentrations;
  - higher concentrations reduce energy requirements for heating, pumping and drying (because higher water temperatures lead to faster de-watering on the wire).
- ***reducing the fresh water input*** reduces the water reaching the water treatment plant and therefore:
  - reduces the size of (a new) treatment plant thereby supporting the cost-benefit BAT justification of better treatment;
  - saves costs where water is purchased or disposed off to another party.

Against the above advantages, higher concentrations can lead to:

- increased slime leading to deposits and web breaks;
- lower brightness and strength;
- increased consumption of process chemicals;
- corrosion problems, e.g. build-up of chlorides;
- scaling leading to blocking of pipes, shower nozzles, wires and felts;
- possible toxic effects in the ETP;
- problems of hygiene control in tissue, food and medical applications.

Despite these potential problems, the environmental performance of many, particularly older, mills, will be improved by reducing water usage although it should be noted that closing up is more difficult for smaller mills and where the number of product changes is high.

Water use

2.2.3.6 Water use Benchmarks

Benchmarks

For mills for which it is agreed that the generation of fresh water is not BAT (see "Recycling of ETP effluent" and "Closure by tertiary treatment" below), the lower end of the benchmark ranges (Table 2.1) for specific mill types are likely to optimise the benefits of reduced water consumption.

However, the limitations above should be noted especially with respect to particular sectors which may require larger quantities for hygiene reasons. It should also be noted that it is not just the paper type which affects the anticipated consumption but the weight of paper being produced, a lighter paper generally requiring more water per ADt. The important consideration is not so much the numerical level but whether BAT is being used.

Note: Water for the boiler plant is not included in the benchmarks below. Reporting water use is inconsistent within the industry and may or may not include make up and cooling water for the boiler plant. The make-up flow is small (few m^3/tonne paper) but can become a significant fraction as the mill closes up its water system. It should be identified in the application.

Table 2-1 Water Use Benchmarks

BREF Tables 4.17, 5.32, 6.31, 6.34

		Recovered fibre mills			Non integrated mills					
UK Benchmarks	Mechanical pulp integrated with newsprint, LWC or supercalendered	RCF de-inked i/g newsprint or printings / writings	RCF not de-inked i/g cartonboard, testliner, etc.	Tissue with RCF	Fine paper coated or uncoated	Tissue virgin fibres heavyweight or low quality	Tissue, virgin fibres lightweight or high quality	Speciality	Integrated NSSC
m^3/ADt	12-20	8-15	<7	8-25	10-15	10-15	15-25	18-180	2.5-5

In addition to the BREF, advice on cost-effective measures for minimising water can be found in ETBPP publications (see Ref. 8).

Application Form Question 2.2 (part 3)

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

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.

BAT for water efficiency

BREF Sections: 4.4.2, 4.3.5, 4.3.6, 5.3.1-5.3.4, 6.3.1-6.3.6, 6.4.2,

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 on reducing water use beyond a certain level should be identified by each operator, as this is usually installation-specific.

The operator should also provide flow diagrams and water mass balances for the activities (including the boiler plant and the de-ionisation and treatment operations). (See also Section 2.6)

Water efficiency objectives should be established on a mass balance approach. The consumption of the activities should comply with the benchmarks given in Table 2.1. 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:

- ***reducing the gross requirements*** for water;
- ***recycling*** water, in as many positions as possible for:
  - ***unclarified*** whitewater,
  - ***clarified*** whitewater generated usually in the save-all,
  - ***fresh*** water generated by purification of clarified water.
- ***avoiding inhibiting interactions*** to the closure of the water circuits.

Reducing gross water use

Water used in cleaning and washing down should be minimised by:

- vacuuming, scraping or mopping in preference to hosing down;
- evaluating the scope for reusing washwater;
- trigger controls on all hoses, hand lances and washing equipment.

Cont.

Water use

BAT for water efficiency (cont)

BREF Sections: 2.3.1, 3.3.1, 4.3.2, 5.3.1-3, 6.3.1, 6.3.7, 6.3.8, 6.4.2

- Fresh water should only be used for:
  - dilution of chemicals (note that some such as fillers can be diluted with clarified water);
  - vacuum pump sealing (note, below, that this can be much reduced or even eliminated);
  - to make up for evaporative losses (this can be reduced by heat recovery on the machine);
  - for high pressure showers (generally those with pressures greater than 1000 - 2000 kPa);
  - wire section - the HP wire cleaning shower, the couch suction box, trimming and headbox;
  - press section - felt conditioning, lubricating showers for felt and press roll and suction boxes.
- Dry debarking should be used and the wastewater flow should be no more than 2 m^3/tonne wood by minimising water used for log washing and de-icing (where necessary). Fresh water should not be used for this application and the washwaters should be recycled. **(#)**
- Where wet debarking is still used at existing mills, the non-recycled wastewater flow should be minimised with a target of not exceeding 5 m^3/tonne wood. Fresh water should not be used for make-up and the water should be recycled. **(#)**
- Water released from the system to the ETP should be from the dirtiest part of the circuit.
- Control should be simplified, if possible, to give one fresh water input point and one discharge point from the system.
- Fresh water consumption across the mill should be directly measured and recorded regularly - typically on a daily basis.
- Specific points of fresh water use, circuit overflows and recycled water quality should be monitored particularly the discharge to the ETP.
- The shower system should be reviewed to ensure that water use is minimised commensurate with maintaining uninterrupted production. Typically, in cases where no steps have been taken to optimise usage, consumption can be reduced by an order of magnitude. The following parameters are important:

position of shower nozzle, distance between nozzle and felt/wire, type of nozzle, flat or needle jet, nozzle diameter, water pressure, water temperature, oscillating speed of shower pipe,	jet angle, intermittent use, say 10 min/h (also extends wire/felt life), reduction of number of shower positions, use of large nozzles, self-purging designs and internal brushes to minimise blocking.

- Water-sealed vacuum pumps 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 as feed for the showers.
- 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.

Cont.

Water use

BAT *for water efficiency* (cont.)

BREF Sections 6.3.7, 6.4.2

- Accidental discharges particularly on web breaks should be controlled by:
  - designing the broke and backwater tanks with sufficient capacity for such events;
  - computer control of the system which takes into account the levels not only of the whitewater tower but also the broke and pulp towers;
  - broke and whitewater systems which are separate for each machine, especially where machines are producing different, incompatible grades;
  - staff training and a system which rewards low discharges as well as high production.

Recycling principles

For integrated papermaking, water recirculation should be maximised consistent with acceptable pulp and paper quality, energy balances and paper machine runnability. The constraints on reducing water use beyond a certain level should be identified by each operator as this is usually mill-specific.

Recycling is enhanced by maintaining or improving the quality of the clarified and unclarified whitewater to enable it to be used in as many places as possible. (Particular attention should be paid to small non-wood pulp mills, where bleaching may only involve two or three stages sometimes using simple, but inefficient, drum washers/thickeners leading to very high flows of bleaching wastewater (>100 m^3/tonne pulp).

This water quality control should be achieved primarily by using a counter current flow pattern for maximum separation of substances within water loops and employing the thickening of pulp to optimum dryness prior to passing forward in order to minimise the build-up of dissolved substances in each circuit.

BREF Sections: 4.3.6, 5.3.8, 6.3.1, 6.3.2,

Maximising recycling of unclarified whitewater

- Unclarified whitewater from the paper machine.
- Figure 2-2 - (primary loop) should be used for broke re-pulping and bleaching. Water from the bleaching stage and further unclarified whitewater can be used for dilution of fibres in the pulping stages.
- White water from dry suction boxes, shower trays, press section or vacuum pump pit, (i.e. low fibre positions) may be used on the following low pressure showers. This will require a separate tank for the collection of these waters and a fibre guard (e.g. a bow screen) to filter out long fibres or felt hairs. If the quality is not adequate for the process then the whitewater should be clarified first.

Wire section	Press section
Breast roll; couch roll; wire return rolls; knock-off showers; wire cleaning showers (low/medium pressure)	Cleaning of outer section of rolls

- There should be adequate whitewater storage capacity in order to preclude use of fresh water for process make-up plus techniques to prevent deterioration in water quality on storage.

BREF Sections: 5.3.8, 6.4.2,

Maximising the recycling of clarified whitewater

The operator should describe the clarification system employed or planned, identify the positions on which clarified water is still used and justify the level of clarification against the following factors:

- Clarified whitewater should be generated (as well as recovering fibre, (see Section 2.3.2) by filtration of the whitewater in a save-all or equivalent device as shown in Figure 2.2 - (secondary loop). to enable the water to be recycled for use in the shower positions noted above and for the suspension of fillers. Techniques are, in order of effectiveness:
  - membrane technology (typically ultrafiltration)
  - precoated disc filter conditioned with raw pulp
  - other disc or drum filters
  - flotation devices
  - sedimentation
- Filtration should normally be multi-stage with water of the appropriate quality being taken for each application.
- Save-alls should be provided on each appropriate part of the process - either on each machine or, on a multi-ply machine, each ply may have its own water system with its own save-all. This will prevent the situation where water contaminated from dyes or fibres on one machine cannot be recycled to another part of the process. Even where a new installation plans for the same grades on each machine, it must be borne in mind that uses and grades made change over the life of the plant, so that there is a strong preference for individual systems on any new plant.

Cont.

Water use

BAT *for water efficiency* (cont)

- In de-inking/bleaching clarified water should normally be produced internally by flotation, which, with suitable chemical pre-treatment, is able to remove colloidal substances and keep the water aerobic.
- Colour from fibre substantive dyes may be removed by a simple save-all, but if there are a lot of coloured fines then DAF or membrane technology should be considered. Where colour continues to inhibit recycling, recycling can be done selectively when colour combinations permit.
- The use of membrane technologies (notably ultra-filtration) should also be assessed for improving whitewater quality for recycling beyond that possible by save-alls especially for new or upgraded units.

There should be adequate clarified whitewater storage capacity in order to preclude use of fresh water for process make-up plus techniques to prevent deterioration in water quality on storage

Recycling of ETP effluent

BREF Section: 5.4.2,

In many applications the best conventional effluent treatment produces a good water quality (see Section 2.2.3) 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.

Closure by tertiary treatment

BREF Sections: 5.3.4, 6.5.1

Fresh water can be generated by removing the solubles with membrane technology, in line biological treatment or evaporation. These are well established techniques in other industries and have been used in a few pulp and paper installations; membrane technology, in particular, continues to develop and should be kept under review. These technologies can be applied at the machine 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. Although there are very few effluent-free installations operating in the world and only in specific sectors such as packaging and CTMP pulp production, the operator should assess the costs and benefits of providing tertiary treatment to enable further closure of the water circuits **(#).**

Prevent inhibiting factors

BREF Sections: 6.3.2, 6.4.2,

- The water quality (e.g. pH, hardness, temperature) required by specific equipment and its tolerance to abnormal levels should be established so the lowest compatible quality can be used. Replacement of pipes/tanks with more corrosion-resistant materials should be carried out if appropriate.
- Water circuits (e.g. pulping/de-inking from papermaking) should be separated with a counter-current pattern of water movement in order to minimise the transfer of materials that could limit water closure.
- Raw materials should be assessed to minimise the introduction of interfering materials that will otherwise build up on water closure, (see Section 2.2.1).
- Papermaking chemicals should be re-assessed for optimal operation under closed conditions, (see Section 2.2.1).
- All reasonable steps to control the build-up of temperature and substances that could limit the degree of water closure achievable should be taken.
- Design specifications should include features such as smooth surfaces, sufficient flow velocities, larger nozzles, synthetic wires and felts and optimum storage volumes.
- The use of chemicals such as chelants to complex metal ions, dispersing agents and retention aids should be employed where appropriate.
- Microbiological control by biocides, increased temperatures (>45°C) and adding air at critical positions to prevent anaerobic conditions and adding barium salts to bind sulphate ions should be considered where these conditions are limiting closure.

With **the application**, the operator should supply information on:

- water consumption and comparison with benchmarks,
- a diagram of the water circuits with indicative flows (with a level of detail similar to Figure 2.2);
- the current or proposed position with regard to all of the above measures;
- shortfalls in information or justifications for not using the above measures;
- water audits already conducted and the improvements made or planned.

Post application, as described in Section 1.1:

- for both new and existing installations, a comprehensive water audit;
- Implementation of the measures identified and longer-term studies should take place to a timescale agreed with the Agency (although priority should be given to those marked with (#) in the above list all of which should normally be resolved by 30 June 2004);

2.3 The Main Activities and Abatement

(includes **"directly associated activities"** in accordance with the Regulations – see Section 1.3)

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)

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 set out in ***Sections 2.3.1 to 2.3.14.***

BAT *for the main activities*

The operator should provide adequate **process descriptions** of the activities and the abatement and control equipment for all of the activities such that the Agency can understand the process in sufficient detail to assess the operator's proposals and, in particular to assess opportunities for further improvements. If there is uncertainty, the degree of detail required should be established in pre-application discussions. The following items must be included with the application:

- process flowsheet diagrams (schematics);
- diagrams of the main plant items where they have environmental relevance, e.g. incinerator furnace design, abatement plant design etc.;
- details of any chemical reactions and their reaction kinetics/energy balance, in particular for any chemical pulping or bleaching;
- control system philosophy and how the control system incorporates environmental monitoring information;
- annual production, mass and energy balance information;
- venting and emergency relief provisions;
- summary of extant 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.

The operator should **show how the techniques represent BAT** and justify proposals and any departures from any indicative standards given in this guidance as described in Section 1.2 and in the Guide to Applicants.

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).

With **the application**, the operator should:

- provide the descriptions and information listed above;
- describe the current or proposed position for all of the indicative requirements **for each subsection of 2.3;**
- identify shortfalls in information or justifications for not using the requirements;
- demonstrate, by reference to the indicative requirements or otherwise, that the proposals are BAT.

Post application, as described in Section 1.1for existing plant only:

- the completion of any detailed studies required into abatement or control options;
- odour plans, noting that these may be required earlier if there are local problems;
- Implementation of any further measures identified should take place to a timescale agreed with the Agency

Debarking & chipping

2.3.1 Preparing virgin fibre (debarking, chipping)

2.3.1.1 Debarking

Summary of the activities

Process: By the mechanical action between logs whilst they are contained within a rotating drum, either wet with added water or dry.

Water: The water contains BOD and wood-derived organics that have some aquatic toxicity. Wastewater is normally clarified to remove debris and recycled to varying degrees, but there is always some discharge from debarking. In dry debarking the wastewater flow is minimised, but not eliminated, as a small flow of water is used to wash or de-ice the debarked logs.

Land: There is a small potential for run-off of pesticides from log stores and bark heaps.

Air: Dust from bark stores and local odour.

Waste: Bark for disposal or energy recovery. Typically 100 kg/tonne wood, and accounts for 50% of the waste generated on a typical pulp mill. In the wet process, bark has to be pressed to remove water before burning to recover the energy. Final release will be as CO_2 and water vapour, with NOx and particulates depending on design and abatement of the combustion plant.

Energy: Dry debarking yields more net energy on combustion of the waste bark than wet, for obvious reasons.

Accidents: Not significant.

Noise: Trucks, mechanical handling of heavy loads, chains etc may cause nuisance especially if close to the site boundary.

BAT

BREF Sections: 2.3.1, 3.3.1, 4.3.2

Application Form Question 2.3 (cont.)

BAT for Debarking is as follows:

The main control issues are:

- Water efficiency techniques should be employed - see Section 2.2.2.
- Waste should be recovered - see Section 2.6.

No further issues are identified.

2.3.1.2 Chipping

Summary of the activities

Process: Before pressurised refining or chemical pulping the logs are converted into 10-35 mm chips and washed to remove contaminants (stones, etc.).

Water/land: No direct release but there is the potential for run-off of resin acids from stores.

Air: Potential for dust blown from outdoor stores, localised odour.

Waste: Not significant.

Energy: Moderate.

Accidents: Not significant

Noise: Significant, may be indoors or outdoors. In the latter case there is considerable scope for noise problems.

BAT

BREF references: see the appropriate section referred to.

Application Form Question 2.3 (cont.)

BAT for Chipping is as follows:

The main control issues are:

- Noise abatement required - see Section 2.9.
- Dust control - see Section 2.3.10.
- Run-off control - see Section 2.3.11.

No further issues are identified.

De-inking

2.3.2 Preparing recovered fibre - including de-inking

No. of UK mills	
Paper mills integrated with de-inking including:	18
De-inking mills integrated with mechanical pulping	1
De-inking for tissue/towel	10
De-inking for newsprint	3
De-inking for other printing/writing grades	5

Summary of the activities

BREF Section 5.1

Process: Wastepaper or packaging (depending on the required product) is re-pulped in a hydropulper, followed by stages of mechanical cleaning and de-inking. Typically fibre is de-inked for newsprint and printings/writings but not for packaging. The quality of the waste used for tissue (waste printings/writings) means that it too can sometimes be used without de-inking.

De-inking is a chemi-mechanical process for removing ink and other materials. The mechanisms are removal (e.g. of stickies, ink, filler, dyes in screens, flotation cells and bleaching), change of physical characteristics of the materials (e.g. disperging disperses remaining ink particles) and change of chemistry (e.g. reductive bleaching of lignin/dyes).

A typical process is shown in Figure 2-4 - Typical De-inking System, but the sequence varies considerably. Two basic approaches are taken:

BREF Figs 5.1 - 5.4

- **Wash de-inking** involves diluting the waste paper suspension and dispersing the inks, by chemical or mechanical means, so they are removed with the water phase after de-watering. Chemicals used are surfactants such as alkylphenolethoxylate. Washing is effective at removing smaller ink particles (less than 10µm).
- **Flotation de-inking** typically uses fatty acid soaps with calcium, or synthetic alternatives, to bind to the ink, and allow it to be floated off as a scum. This is effective with the larger particles (greater than 50 µm). In some cases a combination of techniques has been used although the flotation techniques are most common in UK de-inking plants.

After either system, water is removed in a thickener followed by further cleaning and washing and a disperging stage to avoid any visible spots. The scum from the flotation units is de-watered to give a sludge of 20 - 50% solids.

BREF Tables 5.1 - 5.4

Water: Large quantities of water are used in de-inking, but are largely recycled. Water is supplied from the papermaking machine to the later de-inking stages and then recycled, counter-current, through the stages. Water from an integrated system would leave the circuit with the scum from the flotation cell and with the cleanings/screenings, i.e. from the dirtiest parts of the circuit. The remainder of the water passes forward again, with the pulp, to the paper machine.

BOD/COD and contaminants are higher in de-inked wastewaters than in other papermaking activities (excluding pulping), e.g. up to 20 kg COD/tonne pulp for newsprint de-inking. The contaminants reflect the original pulp, the papermaking chemicals and printing inks used. The de-inking wastewater is treated with the papermaking wastewaters (see Section 2.3.11).

Air: Process emissions are unlikely except where chlorine compounds (mainly hypochlorite) are used for bleaching of wood-free grades (see Section 2.3.7). Localised fugitive emissions of dust, loose paper and odour, possibly from starches released in the warm water.

Land: Indirect only; see Section 2.6 regarding sludge to land issues.

BREF Tables 5.1 - 5.4 5.15 - 5.18

Waste: As a cleaning process, de-inking inevitably results in losses. Losses depend on the quality of the recovered paper compared to the required specification of de-inked pulp. Waste comprises:

- de-inking sludge, which comprises:
  - fibre fines too small, due to repeated re-pulping, to be held in the paper web;
  - mineral fillers; the fibre:filler ratio depends on the wastepaper and the product;
- separated trash/rejects plastic fragments, fibre, etc.; typically 40-80 kg/t input material;
- heavy metals from inks and dyes; typically 1/10 of the levels in sewage sludge;
- organics (soap and polymers) and trace organics such as PCBs and PCP.

De-inking

The quantity of de-inking sludges varies from newsprint at 170-200 kg/tonne to tissue at 500-600 kg/t paper. Sludges are usually handled with wastewater treatment sludges. The large quantities make on-site energy recovery likely as a viable option.

BREF Tables 5.1 - 5.4 & 5.8 - 5.9

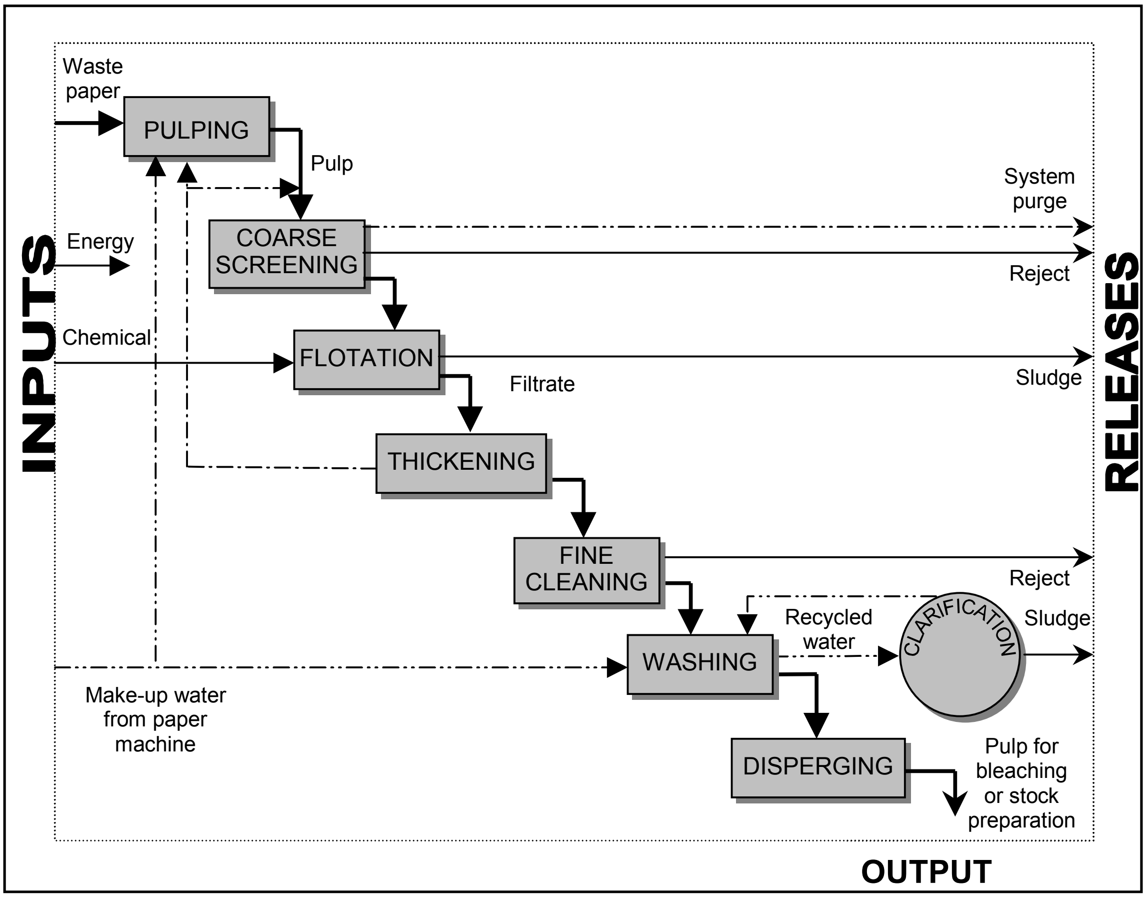
Energy: Energy use in de-inking is higher than in mechanical cleaning due to the additional stages. Steam is used to aid initial fibre dispersion, and to heat the stock before dispersing. Electrical consumption is 150-500 kWh/tonne pulp depending on grade, see BREF Table 5.1.

Accidents: Storage of chemicals.

Noise: Not significant.

Cross-media: For a summary, see BREF Table 5.20.

Figure 2-4 - Typical De-inking System



BAT

BREF references: see the appropriate section referred to.

Application Form Question 2.3 (cont.)

BAT for De-inking is as follows:

The main control issues are:

- the treatment of the significant organic wastewater loads, see Section 2.3.11;
- water efficiency issues, see Section 2.2.2;
- disposal of the de-inking sludge, see Section 2.6;
- the disposal of separated trash/rejects plastic fragments, fibre, etc., see Section 2.6;
- the control of dust and loose paper, see Section 2.3.12.

In addition:

Where there are particular pollutant issues to water, e.g. cadmium or PCP, then consideration should be given to waste paper selection (see Section 2.2.1) or further wastewater treatment (see Section 2.3.13). However, it also needs to be borne in mind that any waste paper not recycled is still largely a waste. The Agency will endeavour not to apply conditions that inhibit this recycling process.

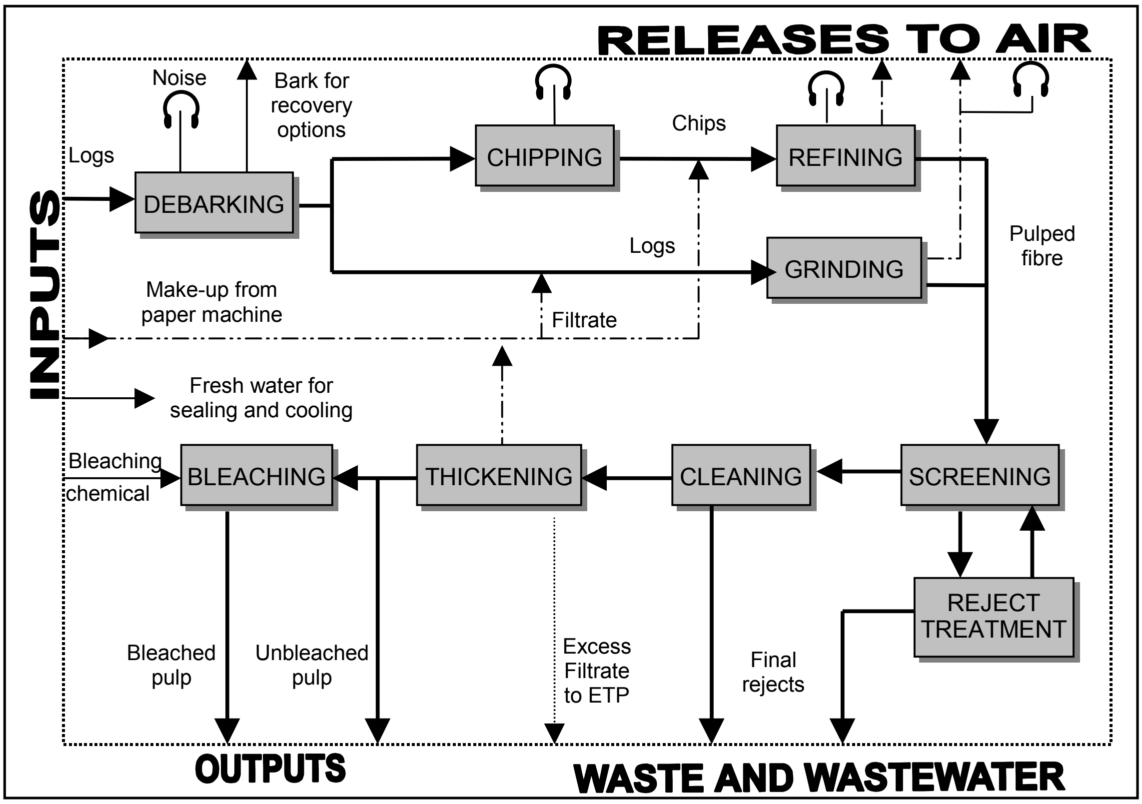
Mechanical pulping

2.3.3 Mechanical pulping

No. of UK Mills	
Mechanical mill integrated with on-site de-inking	1
Mechanical mills with on-site coating	2

(See Figure 1.1 for the basic pulping operations).

Figure 2-5 - Mechanical Pulping



Summary of the activities

BREF Section 4.1

Process: Mechanical pulps are used to make wood-containing papers (newsprint and light-weight coated [LWC] papers) and wood-containing boards (folding boxboard). The process separates the individual fibre bundles by applied physical force aided by the elevated pressure and temperature achieved naturally or by the addition of steam. There are two types of mechanical pulping process:

- groundwood processes in which the logs are pressed against a large rotating grindstone,
- refiner processes in which chips are forced against barred rotating discs.

The original stone groundwood (SGW) process has been superseded by the pressurised groundwood (PGW) process, of which there is one example in the UK. The original refiner mechanical pulping (RMP) process has been superseded by the thermo-mechanical pulping (TMP) process, of which there are two examples in the UK.

After pulping, the pulp is screened to remove non-separated fibre fragments and the rejects treated further mechanically in refiners before they are returned to the pulp flow. Finally, the pulp is cleaned and thickened before an optional bleaching stage

Water: Water-soluble pulp components dissolve in the process water comprising a wide range of organics (see releases to air below) which may or may not be biodegradable and may be harmful. Also metals such as cadmium and manganese, usually bound with soluble, but poorly biodegradable, chelants, and oxygen-demanding inorganics such as sulphites from a CTMP pulping process. Some will be retained with the paper product depending on the chemistry on the paper machine and its degree of water closure; but most end up in the combined mill wastewater. The quantity reflects the yield of the pulping process (92-97%) and covers the range 30-80 kg COD/tonne pulp. The BOD is 40-50% of the COD and, despite their biodegradability, some of the organics exert a significant toxicity to aquatic life.

Mechanical pulping

Summary of the activities

Air: As a consequence of the high process temperatures, volatile wood compounds are released with the process steam and smaller quantities can be emitted from wood and chips. This is particularly true for the steam-assisted pulping processes TMP and PGW. For example, from a 1000 ADt/day PGW installation, with unabated steam release, emissions could be:

turpentine	4000 kg	ethanol	250 kg	acetic acid	50 kg
methanol	20 kg.	fatty acids	30 kg	formic and resin acids	10 kg

Some of these will condense with the steam; most plant still have a significant steam release to atmosphere which will inevitably carry a significant proportion of this load with it.

Considerable fines are also generated and pass forward with the steam. They are usually removed with a cyclone and rejected.

Land: Localised resin acid run-off from any timber stores on bare ground.

Waste: Small quantities of unseparated fibres, the latter being usually recycled for further pulping. Fines captured in the cyclone should be used for energy recovery if available.

Energy: Consumption depends on the pulping method and the quality requirements of the product. For example electricity, 1-2 MWh/tonne pulp for grinding systems versus 1.5-3 MWh/tonne pulp for refiner systems.

Overall mill requirements	Integrated newsprint	Integrated LWC	Integrated SC
Steam GJ/ADt	0-3	3-12	1-6
Electricity MWh/ADt	2-3	1.7-2.6	1.9-2.6

The pressure released after pulping generates considerable quantities of steam which is usually recovered (after passing through a cyclone to remove particulate solids) for water heating or passed to the paper machine for use in drying. In the case of TMP, it also provides the steam for pre-heating the wood chips. The proportion of the input energy that is recoverable varies with the process from about 30% for PGW to 70-80% for RMP/TMP.

Accidents: Spillage of CTMP liquors.

Noise: Very significant.

BAT

BREF Sections: 4.3.3 to 4.3 7 and 4.3.10

Application Form Question 2.3 (cont.)

BAT for Mechanical Pulping is as follows:

The main control issues for mechanical pulping are:

- abatement of the VOCs and steam plume from the refiners, see Section 0;
- the control of wood-derived aquatic toxicity which should be controlled by minimising water use, see Section 2.2.2 and abated by biological treatment of the wastewater, see Section 2.3.11, (see also De-barking);
- the control of other soluble materials in the wastewater (e.g. COD/colour from lignins and BOD/COD from hemi-cellulose) which should be limited by minimising water use, see Section 2.2.2;
- Energy consumption is mainly determined by the pulping method and should be taken into account when installing new plant, see Section 2.7;
- the control of noise, see Section 2.9.

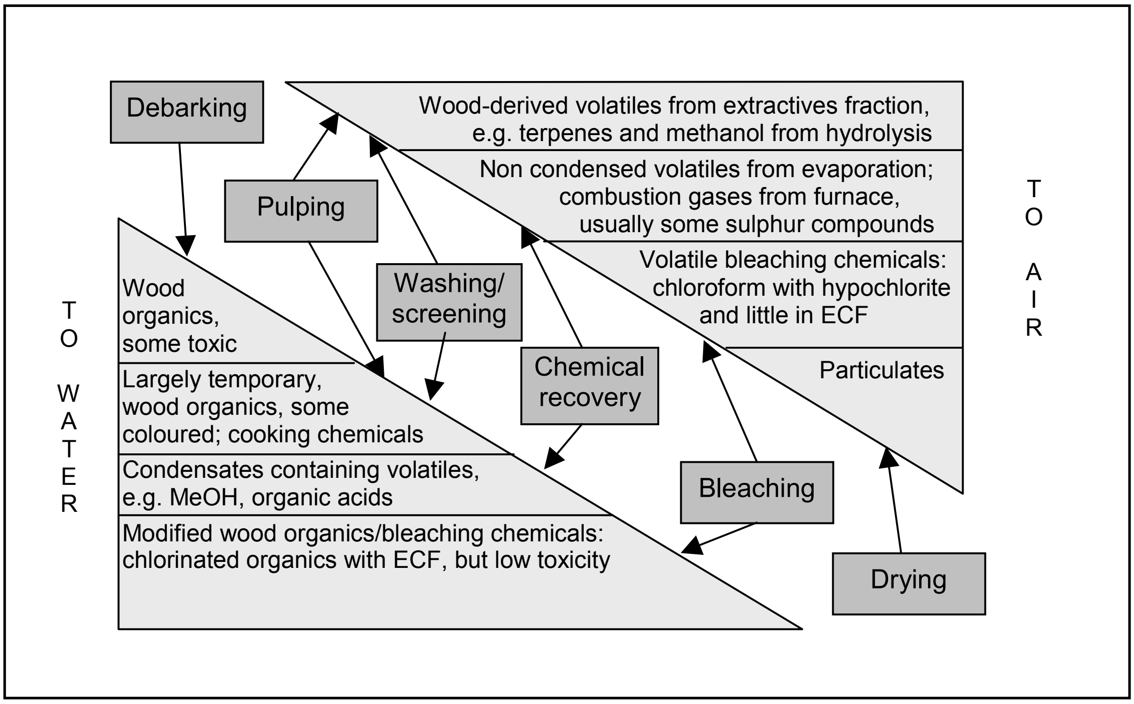
In addition:

- the small quantities of unseparated fibres (which are usually recycled for further pulping) should be minimised through optimisation of pulp screening and cleaning operations. This optimisation should balance the extra energy used in recovering useful fibre from rejects against the energy otherwise gained from reject combustion (where present);
- or any CTMP developments; the alkaline peroxide process rather than neutral/alkaline sulphite should be used, in order to minimise emissions of SO_2.

Chemical pulping

2.3.4 Chemical pulping (main processes)

Figure 2-6 - Summary of Environmental Impacts for Chemical Pulping



Summary of the activities

Process: Following on from the overview given in Section 1.7, the fibres are broken down chemically in pressure vessels, called digesters, which are heated, traditionally spherical, pressure vessels, usually arranged to rotate to unload the contents. There are a number of different chemical pulping methods:

BREF Chapter 2

BREF Chapter 3

- **sulphate Kraft** uses sulphates under alkaline conditions to dissolve the lignin (45% of EU production – none in the UK);
- **sulphite** process uses sulphites, under a range of pH, to dissolve the lignins (11% of EU production – none in the UK);
- **NSSC** process combines both chemical and mechanical pulping (6% of EU production);
- **other** chemicals:
  - hydrogen peroxide for various non-wood fibres (1 such mill in the UK);
  - sodium hydroxide, alone or with sodium carbonate, with a catalyst such as anthraquinone;
  - others, developed mainly on alcohol as a solvent.

Because more of the wood (mainly lignin) is removed in chemical pulping, yields (kg pulp/kg timber) are less than with mechanical pulping. The quality is better, however, as the fibres are not mechanically damaged and the lack of lignin produces a whiter, more stable paper.

Most chemical pulp mills recover the pulping chemicals and the wood organics from the liquor. The organics are used for a variety of products or, more normally, as process fuel. None of the UK mills, which are mainly small or specialist, recover the liquor.

BREF Tables 2.3 - 2.11 and 3.5 - 3.6

Water: At mills with chemical recovery, most of the dissolved wood substances are combusted and the wastewater mainly contains the organics in condensates plus, at bleached mills, the substances dissolved during bleaching and the residues of the bleaching chemicals.

At mills with no chemical recovery (all in UK at present), all the dissolved wood substances and pulping/bleaching chemicals remain in the wastewater apart from the volatiles incidentally released to atmosphere. This could reach 1000 kg COD/tonne for non-wood pulps and 300 kg COD/tonne for NSSC wood pulps. The COD contains much more non-biodegradable, and usually toxic, lignin compounds than from mechanical pulping.

BREF Sections 2.2.2.3 & 3.2.2.4

Air: Sulphite/sulphate processes will release a variety of highly odorous sulphur compounds both from the pulping activities and, particularly, from the chemical recovery activities.

Chemical pulping

In addition there will be NO_x, SO_x, alcohols, terpenes, phenols, fatty acids, resin acids, particulates (mainly sulphates, carbonates and chlorides) and PAH in small quantities. Refer to the BREF if any recovery processes are proposed in the UK.

BREF Tables 3.11 and 2.18

Land: Indirect or via accidents.

Waste: 20-70 kg/tonne pulp comprising ash, ETP sludge, fibre, wood waste and waste chemicals.

BREF Tables 2.23 - 2.30 and 3.23

Energy: Many chemical pulping mills with chemical recovery are virtually self-sufficient in energy needs from combustion of wood wastes and pulping liquor such that these are an inherent part of the mill economics. See the BREF for Kraft and Sulphite mill energy figures.

Accidents: Mainly those associated with the storage of chemicals.

BREF Tables 2.31 and 3.12

Noise: Significant from all chemical pulp mills; many mills are operating at 50 dB(A) at 500 m.

Cross-Media: The main cross-media issue is that recovery decreases emissions to water but increases those to air although this is balanced by the energy recovery. For the comparison of the cross-media impacts of different techniques, see BREF Tables

BAT

BREF Sections: 2.3.2, 2.3.16, 2.3.20-22, 2.5.5, 3.3.2, 3.3.14

Application Form Question 2.3 (cont.)

BAT for General Chemical Pulping in the UK is as follows:

Most of the techniques given in the BREF for these installations are not relevant to the UK situation. The following techniques may be applicable in the UK, either now or in the future:

- For any new installation there should be sound reasons for wishing to use a process which involves the use of sulphites and sulphates for cooking. Processes using peroxide, carbonate, hydroxide or alcohols should be used in preference where possible. The cooking method and any associated recovery plant should be chosen, not only to minimise releases to air and water, but also to be amenable to environmentally acceptable bleaching regimes.
- Any new process using sulphate or sulphite would, however, normally be expected to incinerate the liquor and recover the cooking chemicals and any other substances in the spent liquor (see below) wherever possible and to employ the other techniques described in the BREF.
- The most likely candidate for a new chemical mill in the UK would be based on straw. The pulping of straw should be achieved without the use of sulphates or sulphites - sodium hydroxide/sodium carbonate has, for example, been used successfully.
- Mills with batch digesters should displace the hot black liquor at the end of the batch with cooler liquor from the filtrate tank. This lower temperature reduces the emissions of sulphides and mercaptans and as the displaced hot liquor is used to heat incoming white liquor the energy requirements are also reduced. With appropriate design this can actually increase production.
- Applicable to sulphite mills, magnesium or sodium bases should be used, in preference to calcium, to make recovery possible.
- Applicable to NSSC or sodium sulphite pulping, the use of alternatives such as sodium carbonate and sodium hydroxide should be considered. This avoids sulphide and sulphate releases but is only applicable where the weaker and darker resulting pulp would be acceptable.
- Other possibilities for alternative pulping chemicals are solvent pulping with alcohols such as using sulphite with 9,10-anthraquinone (AQ) and methanol which provides a bright pulp requiring little extra bleaching. With a number of these now under construction, their performance should be addressed in any application.
- High consistency refining should be used where possible. Potentially as it can eliminate the need for subsequent screening and reduce BOD loads.
- Where the pulp is to be subsequently bleached there are pulping techniques which increase de-lignification to minimise the bleaching needed. Extended cooking should be used where possible as this can reduce the bleaching chemical requirement by 25%, and catalysts e.g. polysulphide or AQ, should be employed. The use of AQ also decreases the generation of sulphurous compounds. The use of AQ on the NSSC process has not, however, been evaluated.
- For any recovery developments see the BREF sections referred to above.

Other control issues are:

- the control of wood-derived aquatic toxicity which should be controlled by minimising water use, (see Section 2.2.2) and abated by biological treatment of the wastewater, see Section 2.3.11 (see also De-barking);
- the control of other soluble materials in the wastewater (e.g. COD/colour from lignins and BOD/COD from hemi-cellulose) which should be limited by minimising water use, see Section 2.2.2;
- Odour - see Section 2.3.14.

NSSC pulping

2.3.5 (NSSC) pulping and chemical recovery

No. of UK Mills	
NSSC process, pulping wood, integrated with papermaking	1

See Figure 1.1 for the basic pulping operations.

Summary of the activities

Process: In semi-chemical pulping, chemical and mechanical methods are combined. The chips are partially softened with chemicals after which they are refined. Compared with chemical pulping, yields are higher (~80%) because more lignin is left in the product pulp and the chemical usage is lower. It is a much milder process than Kraft or full sulphite.

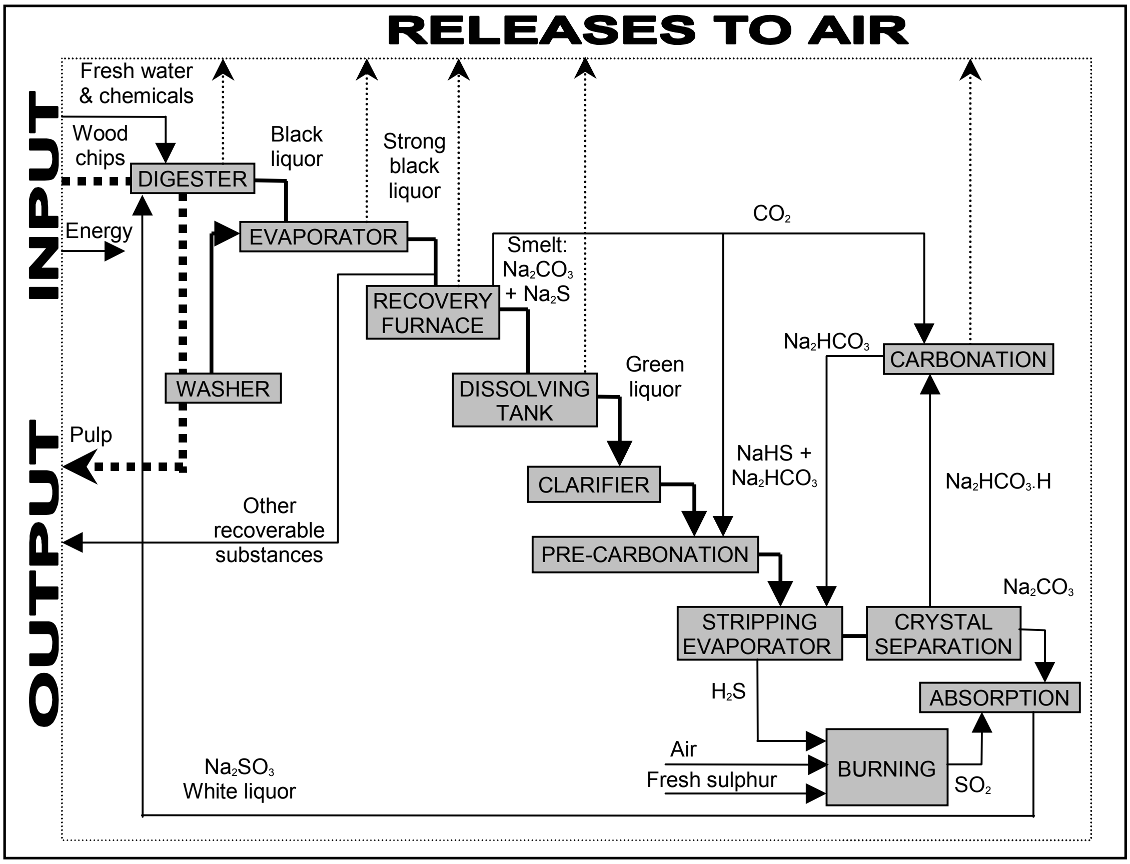
The main semi-chemical process is the neutral sulphite semi-chemical (NSSC) process which produces a pulp from hardwoods and is used primarily for high quality, strong fluting for packing cases. NSSC mills do not necessarily de-bark the wood before the chipper.

Sodium sulphite is the main cooking chemical with a small quantity of sodium carbonate or hydroxide added to buffer the pH in the neutral region. The cooking conditions are optimised to maximise yield for economic reasons and, particularly at mills where the pulping liquor is not evaporated and burnt, to minimise wastewater losses. The digested pulp is refined to optimise its papermaking qualities and the pulp is then finally washed.

Chemical recovery is more difficult than in full chemical processes because the spent liquor is far less concentrated; however, recovery processes are available, the most common being based on acidification of the smelt liquor to release hydrogen sulphide which is then oxidised back to sulphur dioxide by burning.

It is possible to produce semi-chemical pulp with only a soda cook and this simplifies the recovery process, but the pulp quality is not suitable for all applications.

Figure 2-7 - Typical Recovery System for NSSC



Water: Because of the use of hardwoods the resin acid content will be lower but there will still be significant releases of fatty acids and other wood organics.

Where there is no chemical recovery, the wastewater load reflects the yield of the pulping/bleaching process, and could reach 1000 kg COD/tonne for non-wood pulps and 300 kg COD/tonne for NSSC wood pulps.

NSSC pulping

Summary (cont.)

Air: Where a recovery furnace is used, releases are relatively low in sulphides but will contain sulphur dioxide from the absorption towers, blow pits, furnaces, and evaporators. Sodium sulphate particulate will be released. At NSSC and alkaline sulphite mills not having any chemical recovery systems, oxidised sulphur compounds can be emitted to air, but this is minimised by the neutral/alkaline pH.

Land: As for other chemical pulping methods - see above.

Waste: As for other chemical pulping methods - see above.

Energy: At NSSC mills, the high pulp yield means that the quantity of wood-derived organics is relatively low and that, unlike the full Kraft and sulphite processes, auxiliary fuels have to be used for liquor combustion. The energy consumption at integrated NSSC and non-wood pulp mills without liquor burning and chemical recovery would be less than in the full Kraft process.

Accidents: As for other chemical pulping methods - see above.

Noise: As for other chemical pulping methods - see above.

BAT

BREF Sections: - not applicable

Application Form Question 2.3 (cont.)

BAT for NSSC Pulping is as follows:

In addition to the general techniques for chemical pulping given above, the main control issues for NSSC are associated with the handling of the black liquor. The black liquor is of lower concentration than for full chemical processes and therefore recovery is not often practised. The liquor is, however, unacceptable for long-term release into the environment with a BOD of 30,000 plus, high COD and high toxicity.

The first consideration should be the options for recovery (which is still possible when sodium carbonate is used instead of sulphites) but because of its low calorific value the recovery of NSSC liquor would be a net consumer of energy (resulting in increased pollution loads to the atmosphere) and, depending upon the characteristics of the particular effluent, this may not represent BAT.

The second consideration should be the options for recycling. The liquor from either sulphite or NSSC pulping contains substances, particularly ligno-sulphonates, which are potentially saleable. Ligno-sulphonates have been used as binders in oil drilling muds, dispersants, emulsifiers, sequestrants (chelating agents) and fluting additives and can be oxidised to vanillin (used widely as a flavouring and perfuming material). In order to do this the ligno-sulphonates need to be concentrated to around 25%. This is more difficult in the case of NSSC where the starting concentration is likely to be lower; however, it can be achieved as part of a recovery system or by the use of ultra-filtration.

There are companies specialising in the use of ligno-sulphonates and finding a commercial use can help to offset the cost of removal. Ligno-sulphonates in a more dilute form have also found applications in road building and animal feedstuffs. An assessment should be made of the potential for these waste recovery options.

As part of the process of concentrating the ligno-sulphonates much of the more degradable BOD can be removed by fermentation to produce either alcohol or yeast protein by actions on the hexose and pentose sugars and acetic acid. This can remove up to 80% of the BOD. Also decreased sulphur:sodium ratio and maximum pH in cooking liquors (i.e. minimum sulphidity) could be employed to maximise the conversion to ligno-sulphonate.

These options should be considered in any application using sulphites and employed where possible. Where routes for the waste products are found, contingency plans should be available in the event that the route disappears due, for example, to the closure of another company with which such synergy was proposed.

The most likely option to represent BAT, however, would be anaerobic/aerobic biodegradation with energy recovery which would give a positive energy balance. The strength of the liquor is such that a number of stages of biological treatment are likely to be required.

Other chemical pulping

2.3.6 Other chemical pulping processes

No. of UK Mills	
Alkaline pulping processes plus other chemicals (e.g. sodium sulphite) to aid de-lignification, pulping non-wood fibres (hemp, straw etc.), without bleaching.	3
Alkaline pulping processes plus other chemicals (e.g. sodium sulphite) to aid de-lignification, pulping non-wood fibres (hemp, straw etc.), with bleaching.	1

See Figure 1.1 for the basic pulping operations.

Summary of the activities

The use of the **alkaline sulphite process** by non-wood mills is invariably operated in a batch rather than continuous cooking mode due to the small throughput of the plants. Chemical recovery is generally not practised at such mills due to their small size and the complexity of chemical recovery from what is normally a sodium base process.

BREF Chapter 3

The sulphate and sulphite pulping processes have dominated chemical pulp production for many years. In both cases, the presence of sulphur compounds introduces the potential for the release of undesirable sulphur compounds, particularly to air, and this potential is realised at most mills. Over the years, there has therefore been much interest in developing sulphur-free processes that have all the benefits of the Kraft process in terms of pulp quality and process flexibility, but which are less capital-intensive and use chemicals with fewer inherent problems. The aforementioned soda process is somewhat like a sulphur-free Kraft process, but its de-lignification ability is inadequate for low yield, high white, wood pulping. Its application to non-wood pulps is widespread and it is also used with oxygen for straw pulping.

The main area of development for novel pulping processes has been solvent pulping with ethanol or methanol as in the Alcell, Organocell and ASSAM processes, but none have yet proceeded to a viable full-scale installation. Another similar process is Milox using formic acid and hydrogen peroxide. A much-researched alternative approach to purely chemical pulping is bio-pulping using whole organisms or separated enzymes. Benefits have been demonstrated for enzymatic pre-treatment before mechanical pulping and before chemical bleaching, but it is very unlikely that bio-pulping could produce equivalent pulps to Kraft on its own.

In the soda process, the chemistry is simplified as there is no added sulphur to form undesirable by-products and the hydroxide can still be recovered by lime causticisation of the sodium carbonate smelt. After cooking, pulps that are not to be bleached are refined to separate the fibres.

BAT

Application Form Question 2.3 (cont.)

BAT for Other Chemical Pulping is as follows:

Techniques relevant to the sulphite processes are covered in the main processes above.

Techniques relevant to the developing processes will need to be assessed on a case by case basis taking into account the general measures described in the above sections.

Bleaching

Summary of the activities

2.3.7 Bleaching

Process: Bleaching uses chemicals to brighten the pulp. Brightness is measured on an ISO percentage scale on which 88% is the brightest pulp distinguishable by eye and 55 - 60% is the brightness of typical newsprint.

The cellulose and hemi-cellulose are inherently white and it is the lignin that is primarily responsible for the colour. The quantity of residual lignin is expressed in terms of a Kappa Number. A chemical pulp with lignin minimised (to minimise subsequent bleaching) would have a Kappa No. between 10 and 20, and a finished bleached paper <1.

In mechanical pulp which has a large lignin content, it is impracticable to remove the lignin in order to brighten the pulp, thus certain chemicals are used which change its structure in a temporary way (newsprint fades). In chemical pulp the majority of the lignin has been removed in the pulping stages and bleaching is basically a continuation of the process of removing the remaining lignin, although bleaching is normally divided into a de-lignifying stage, removing around 75% of the residual lignin, and a further brightening stage.

Because the lignin content is less to begin with, hardwoods and straw pulp are easier to bleach by methods other than chlorine.

There is a range of different options for the number of stages of bleaching and the chemicals used in each stage. In some stages the lignin is dissolved and in others it is extracted from pulp. The following bleaching methods are used:

- chlorine
- chlorine dioxide
- enzymes
- sodium hypochlorite
- hydrogen peroxide
- ozone
- oxygen de-lignification
- nitrogen dioxide and hypochlorous acid
- sodium hydrosulphite, sodium bisulphite, sodium chlorite, sodium permanganate, sodium chlorate and sodium perborate

Water: From chemical bleaching, releases to water comprise a very considerable BOD/COD loading from the reaction of the bleaching chemicals with the organics. Chlorine bleaching leads to chlorinated species from chloroform to chlorophenols, dioxins and furans:

Table 2.2 Chlorinated species released to water

Bleaching sequence	AOX (kg/ADt of pulp)	Higher (3-5) chlorinated phenolics (g/ADt of pulp)
Chlorine based	8 - 9	80 - 100
Oxygen de-lignification followed by 50% substitution of chlorine by ClO_2	1.5 - 2	5 - 10
As above with 100% substitution (i.e. ECF bleaching)	<1	<2
Totally chlorine free (TCF) bleaching	0.005	

From mechanical pulps, releases will include sulphates from hydrosulphite bleaching. Peroxide bleaching releases more organics (up to 40 kg COD/tonne pulp) than in hydrosulphite bleaching (<5 kg COD/tonne).

Air: Chlorine, chlorine dioxide, dioxins and furans from chlorine bleaching. Sulphur dioxide from on-site manufacture of chlorine dioxide. Chloroform from hypochlorite bleaching.

SO_2 from hydrosulphite bleaching, mainly of mechanical pulp.

Fibrous particulates from flash-drying when pulp is exported.

Land/Waste: None.

Energy: For bleached chemical pulp mills, the energy use in the bleaching stages is quite small (<1 GJ/tonne), but the on-site generation of some bleaching chemicals (e.g. ozone) is high.

Accidents: Accidental release of bleaching chemicals from storage.

Noise: Not significant.

2.3.7.1 Mechanical, or recovered mechanical, pulp bleaching

BREF Section 4.1.3

Process: Only two types of bleaching are used for mechanical pulp:

- The oxidative bleach hydrogen peroxide (dose up to 30 kg/tonne pulp). This is used under alkaline conditions provided by caustic soda or sodium silicate plus added chelant (normally DTPA) to complex interfering metal ions. Peroxide-bleached pulps are neutralised with a suitable acid, e.g. sulphuric
- The reductive bleach sodium hydrosulphite/dithionite (dose up to 10 kg/tonne pulp). This is used under slightly acidic conditions (pH 5.5-6.5) again with added chelant.

Bleaching

Bleaching of mechanical pulps is normally a single stage process followed by final thickening. Two-stage bleaching may be used when pulps of very high brightness are required. At some mills, bleaching is seasonal depending on wood quality.

2.3.7.2 Chemical, or recovered chemical, pulp bleaching

BREF Sections 2.1.7 and 3.1.5

Process: Bleaching of virgin chemical pulp is only practised by one UK (non-wood) pulp mill, in a non-standard application. See BREF Section 2.1.7 for an explanation of the sequences and options. The main issue is the use of chlorine, chlorine dioxide (elemental chlorine free - ECF) or totally chlorine-free (TCF) techniques.

The bleaching stages are operated on a continuous basis in upflow or downflow towers usually at elevated temperatures and sometimes pressurised. Changing bleaching chemistry at existing mills can be difficult due to the different chemical conditions and construction materials required. After each bleaching stage, the pulp is washed/thickened to remove dissolved materials. Typically three to five stages of final drum washes would follow. The chemistry of the final bleaching stage determines the chemistry of the pulp, particularly its content of residual bleaching chemicals and bleaching by-products.

Application Form Question 2.3 (cont.)

BAT for Bleaching is as follows:

BAT
BREF Sections: 2.3.4, 3.3.3

Elemental chlorine should not be used in new or existing applications in the UK. The reasons for this are evident from the Table 2.2.

For bleaching mechanical or recovered mechanical pulp or elsewhere where there is no requirement for long life of the paper, brightening techniques that do not dissolve the lignin are preferred as they minimise the COD releases to water; e.g. sodium hydrosulphite, sodium bisulphite, sodium chlorite, sodium permanganate, sodium chlorate, dithionite or sodium perborate. An example of environmental benefit is:

- newsprint unbleached, or brightened by dithionite, leads to 9-18 kg/ADt COD before treatment;
- newsprint when bleached by peroxide leads to ~35 kg/ADt COD.

Techniques that do not use sulphur compounds are preferred to minimise sulphur releases to air.

For bleaching chemical or recovered chemical pulp TCF techniques that also do not use sulphur compounds are preferred although some use significant mounts of chelant (e.g. DPTA) whose potential impact is not fully understood.

- Ozone bleaching is expensive but can give completely chlorine-free bleaching for any brightness.
- Hydrogen peroxide or oxygen/peroxide for bleaching wood or non-wood sulphite fibres.

Where TCF techniques will not provide the quality of product required, ECF bleaching may be used. However, chlorate residues from on-site chlorine dioxide production can be toxic and water system closure may be restricted. Unless appropriate measures are taken ECF would not be the preferred system for any new bleaching plant in the UK.

Thus, even where use is justified, techniques to minimise the use of chlorine dioxide should be taken and the operator should justify where these are not used. Options include:

- **Oxygen de-lignification**, especially when used with extended cooking, has been shown to produce significant reductions in COD, BOD and AOX (40, 30 and 60% respectively).
- **Enzymatic pre-treatment.**
- **Sodium hypochlorite** ccan be suitable for sulphite pulps, coloured broke or broke with wet strength agents. Its use produces less highly substituted chlorinated organics than when using chlorine, but far more chloroform. It does not require the use of chelants.
- **Oxygen and hydrogen peroxide** will reduce further the formation of chlorinated compounds. In particular, replacing hypochlorite with hydrogen peroxide will reduce chloroform releases to air.

Bleaching tanks should normally be covered to suppress releases of chlorine, chlorine compounds or sulphur dioxide to air. While the concentration of such substances may be high, unless direct contact steam heating is employed, the mass flow from the cover vents will normally be low. The use of deliberate extraction, may reduce concentration levels but can lead to an increased mass flow. Where releases are significant, they can be abated by alkaline scrubbing (chloroform by adsorption).

Where flash drying is used, appropriate dust abatement should be employed.

Papermaking

2.3.8 Papermaking

Papermaking can be broken down into four main areas plus the water system:

Summary of the activities

BREF Section 6.1

2.3.8.1 Stock preparation

Pulp is converted into a dilute suspension suitable for papermaking. When the paper mill is integrated with pulp production (virgin or de-inked), stock preparation is simplified, there being no initial cleaning stage. Conversely when the paper mill uses non-de-inked recovered paper, stock preparation is quite complex, with a number of cleaning units within the initial cleaning stage. The quantity of rejects removed in this way from recovered paper can be up to 100 kg/tonne depending on its quality. The unit operations within stock preparation are a combination of:

- initial slushing of the pulp to wet the fibres;
- mechanical treatment (refining or beating) to develop the strength potential of the fibres;
- cleaning to remove undesirable particulate contaminants;
- the blending of fibre stream(s) with non-fibrous raw materials.

The only direct waste from this process is the concentrated reject streams, which are either passed to the wastewater drains, kept as a separate semi-solid waste or compacted to a more solid form for disposal. Other than these reject streams, there should be no discharge to effluent except for accidental overflows from tanks. Energy use in stock preparation is significant, the largest user being the pulp refiner.

2.3.8.2 The approach flow system

This is a short section which involves dilution of the thick stock (30-40 g/l) from stock preparation to papermaking consistency (normally 3-10 g/l). Further chemicals (e.g. retention/drainage aids) may be added during this stage and the stock is subject to final cleaning by centrifugal cleaners and a pressure screen. The rejects pass to drain. Energy use is modest, although this stage does involve pumping the largest flow within papermaking.

2.3.8.3 The paper machine

The paper machine takes the dilute suspension of papermaking materials and forms it into a uniform web of paper which is usually wound onto a reel. There are three distinct phases in water removal:

- gravity drainage through the formation wire(s) raising the web solids to 15-20%;
- pressing against absorptive fabrics raising the web solids to 40-55%;
- final drying in contact with steam-heated cylinders to achieve 90-95% solids content at reel.

The initial formation unit is traditionally a horizontal wire (Fourdrinier machine), but there are many different formation units in use today such as vertical gap-formers (e.g. for newsprint), crescent formers (e.g. tissue) and cylinder vats or moulds (e.g. for boards). The wet end of the paper machine is the main source of the mill wastewater through the sub-100% retention of papermaking materials.

The press section comprises three or four stages, sometimes with extended nips to maximise water removal.

The drying section usually involves a long train of small cylinders, but tissue papers are dried against a single large cylinder (Yankee) or by a system of through-air drying. Within the train of drying cylinders, further chemicals (mainly starches) are applied to some paper grades (e.g. most wood-free printings/writings) by liquid pick-up in a size press. Coating is another method of surface application and this will be described in Section 2.3.9. At the end of the drying section, some papers may be given a smoother surface by passing the web through a calendar stack. The drying section is the main user of energy, principally in the form of steam.

2.3.8.4 Finishing operations

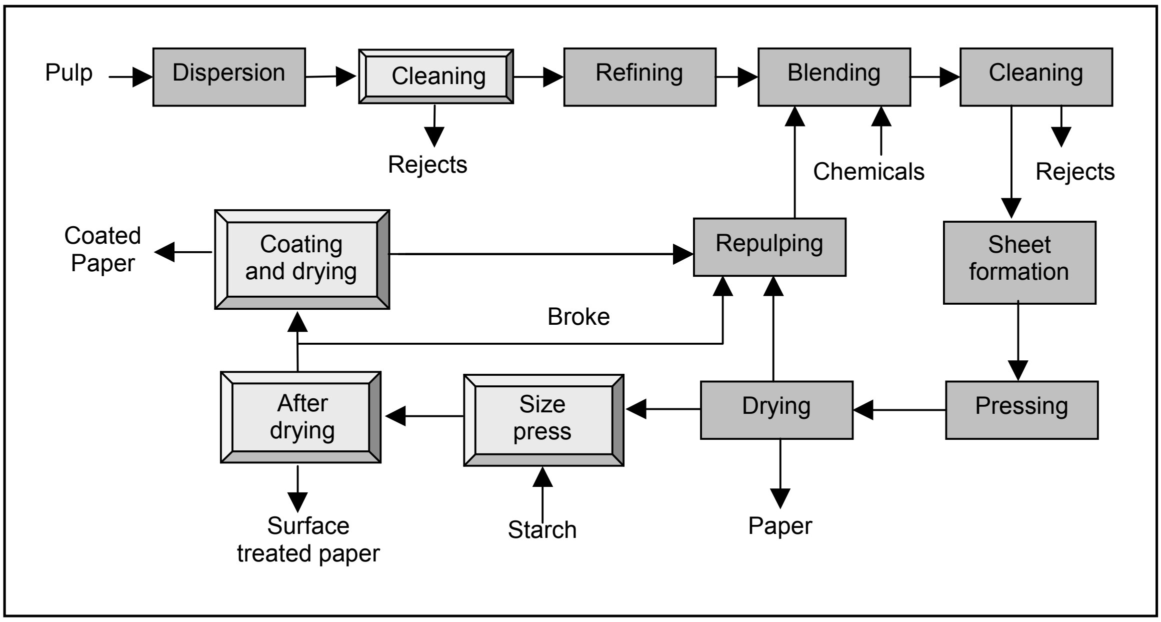
The reeled-up paper is converted into the final form (e.g. smaller reels, sheets) for sale or for further finishing operations elsewhere. These operations involve use of electrical energy, but no releases to effluent trim, break and broke handling.

The required width (deckle) of the paper is controlled by water (deckle trim) jets at the end of the formation wire before the sheet reaches the press section. The trim falls into the couch or hog pit, where it is diluted with (recycled) water and brought back into the stock preparation system, sometimes after thickening. If there is a break on the paper machine (often in the press section), all the formed sheet enters the couch pit and is rapidly diluted by water from knock-off showers and stored for later re-use. All paper machines generate considerable quantities of dry broke, which is repulped and blended with fresh stock. For wet strengthened papers, broke has to be repulped with chemicals (sodium hydroxide or hypochlorite) at elevated temperature and coloured broke may be bleached before re-use.

Figure 2-8 - Stages in the Papermaking Process

Key

Optional Processes



Summary (cont.)

BREF Section: 6.2.2.5

2.3.8.5 Releases

Water: The main release to the environment from papermaking is the wastewater from the various stages of the process. The raw wastewater comprises both continuous and intermittent streams. The main continuous source is the overflow from the main papermaking circuit and press section, but there may be significant flows of relatively clean waters from sealing and cleaning (hoses). Intermittent flows are overflows from tanks with poor level control, wastewaters from chemical cleaning of machine circuits and washouts from some chemical preparation equipment, the most important being starch.

The raw wastewater contains a range of substances in a particulate or dissolved form. The particulate solids are a mixture of fibre and mineral filler plus smaller amounts of associated chemicals such as sizes, starches, etc. Raw TSS levels cover the range 20-100 kg/tonne paper. The dissolved solids are a more diverse mixture comprising the following sets of substances:

- biodegradable organics measurable as both BOD and COD, largely resulting from dissolution of substances from pulps and broke, e.g. wood hemi-celluloses and starches. Raw BOD levels are very dependent on the raw material mix and cover the range 2-20 kg/tonne paper. Some of these substances (e.g. wood-derived resin acids and some biocides) may exert toxic effects. There may also be low levels (1-2 µg/l) of compounds like pentachlorophenol (PCP) originating largely from recycled fibre, where the original source may have been PCP addition to wood chips as a preservative, pulp bleaching with chlorine or use of PCP as a paper preservative. Low levels of other chlorinated organic compounds (measurable as AOX) may also be present from bleached chemical pulps or recycled fibre;
- non-biodegradable organics measurable only as COD, originating again from pulp dissolution (e.g. lignin compounds from virgin pulps and compounds such as CMC) plus non-retained wet end additives, e.g. dyes, brightener, resins, etc. Raw COD levels are very dependent on the raw material mix and cover the range 5-50 kg/tonne paper.
- inorganic ions such as sulphate from alum addition, chlorides from size press sodium chloride addition, calcium from the dissolution of calcium carbonate, etc. There may also be very low levels of heavy metals such as cadmium (from printing inks at recycled mills) and mercury (from some grades of caustic soda), but these may be adsorbed on particulate solids.

Papermaking

Summary (cont.)

BREF Section: 6.2.2.7

Air: formaldehyde from UF and MF resins and ammonia from the breakdown of the urea;

- water vapour;
- odorous substances from microbiological action in mill water and wastewater treatment systems, e.g. the anaerobic conversion of sulphate to sulphide and of dissolved starches to volatile organic acids such as acetic acid;
- particulate is generated on faster paper machines and during finishing/converting operations;
- other VOC releases are usually small, e.g. solvents from wire cleaning (particularly at recycled mills) and carriers in some formulated chemicals, e.g. biocides;
- Chloroform from the bleaching to decolorise broke or break down wet strength agents, where used.

BREF Section: 6.2.2.6

Waste/land: sludges separated during wastewater treatment;

- the concentrated rejects at recycled mills;
- industrial wastes, e.g. baling wires, packaging, redundant equipment, worn-out materials (e.g. wires and felts), etc;
- any broke not recycled due to the presence of colours or specialist fibres.

Most substances present in the water circuit could appear in the papermaking sludge including PCPs, persistent biocides, any chlorinated species, heavy metals, dyes and any other chemicals used in the process.

BREF Section: 6.2.2.4

Energy: Papermaking requires significant quantities of both steam and electricity.

The largest steam use is for drying the paper web. Non-integrated paper production requires more energy as it is necessary to dry the pulp fully for transport. The energy for drying should be minimised by maximising the efficiency of the press section, e.g. by some form of extended nip pressing. Assuming an energy consumption of 3.6 GJ/tonne water removed, the energy saving in increasing the post-press solids content from 45 to 50% would be 0.6 GJ/tonne paper.

The largest use of electrical power at many mills is the refiner for mechanical treatment of the stock, particularly where softwood pulps are used. This can amount to 600 kWh/tonne pulp corresponding to about 2 GJ primary energy/tonne for bought-in electricity.

For mills based on non de-inked recovered paper (e.g. liner/fluting mills), greater power and steam are required for stock cleaning, but this should be minimised by using techniques such as high consistency pulping, stock fractionation and pre-thickening before disperging.

At all non-integrated paper mills, the steam is generated on-site through the burning of fossil fuels, but the electrical power may be either bought-in or generated on-site in a combined heat and power (CHP) plant. The steam/power plant may be owned and operated by the mill or by another company. CHP generation is easily the most energy-efficient means of producing the required balance of steam and electricity at most mills with gas-fired plants being the most popular and having the lowest emissions of all combustion gases.

Electrical power is used across all mills for pumping stock/waters, for mixing in tanks, for cleaning equipment, for driving the various elements of the paper machine, in the finishing department and in wastewater treatment.

Accidents: Most accidental releases occur from spillage of chemicals to ETP, faulty or inadequately labelled drainage systems or ETP bulking (see Section 2.3.11).

BREF Section: 6.2.2.8

Noise: Many parts of the machine are very noisy and require acoustic shelters for worker protection. Standard noise protection measures should be taken to minimise disturbance in the local neighbourhood.

Papermaking

BAT

BREF Section 6.3.4

Application Form Question 2.3 (cont.)

BAT for Papermaking is as follows:

The main control issues are:

- selection of materials - in particular that only ECF or TCF imported pulp is used, see Section 2.2.1;
- water efficiency, see Section 2.2.2;
- abatement of releases to water, see Section 2.3.11;
- releases to atmosphere of VOCs and steam, see Section 0;
- prevention of fugitive emissions to water, see Section 2.3.13;
- prevention of fugitive emissions from finishing operations, see Section 2.3.12.

In addition, the following techniques will minimise waste, minimise the load on the ETP and minimise emissions to air from the bleaching of broke.

- save-alls should be used for the recovery of both particulate solids and clarified water (see Section 2.2.3). Mills can lose as much as 100 kg/ADt fibre, and all fibre losses will end up as a sludge disposal problem. Mills should aim for losses of 10-20 kg/ADt. Save-all efficiency should also be monitored;
- use of retention aids, (see Section 2.2.1) should be optimised to improve particulate wire retention without causing any unacceptable deterioration in paper quality, e.g. formation. This includes:
  - raw material selection, see Section 2.2.1;
  - neutralisation of interfering substances that would otherwise reduce the efficiency of retention aids;
  - monitoring, preferably on-line rather than manual, of wire retentions for fibre and, where present, filler.
- With regard to broke, the operator should quantify the levels for each grade and take the appropriate steps to minimise the production of broke or limit its effect, in particular:
  - uprating of machine control systems (computer control, on-line sensors for grammage, ash content, colour, drive speed, supply of fibre, dosing of additives and wet end retentions and related chemical parameters);
  - wherever practicable, coloured or brightened broke should be re-used in compatible grades rather than bleached or quenched for use in any grade;
  - adequate storage capacity for broke and whitewaters should be provided along with level monitoring in broke/whitewater tanks in order to minimise overflows.
- particulate losses during screening should be minimised; rejects at integrated pulp mills should be returned to the pulp mill wherever possible;
- operation of pulp refiners should be optimised to minimise generation of fines and dissolution of pulp/broke solubles, noting that there is a law of diminishing returns requiring increasing amounts of energy for diminishing recovery of solids;
- machine drains should be monitored for flow and solids content (turbidity) so that total particulate losses can be calculated in kg/tonne paper (target 10-20 kg/tonne);
- materials should be selected, where possible, so as not to inhibit recycling, noting that all production tends to give rise to dry broke. Starches, adhesives, some dyes and wet strength resins are examples of materials which can be difficult to recycle.

Coating

2.3.9 Coating

No. of UK Mills	
Coating associated with mechanical pulp mills	2
Coating associated with on-site de-inking	1
Coating associated with other paper mills	15

Summary of the activities

BREF Section: 6.1.6, 6.1.7

Process: Coating is the application of a pigment suspension to the paper surface to improve printability. It may be performed on the paper machine or on a separate off-machine coater. Coating station(s) are followed by drying. Coating may be on one or both sides of the paper. Coating weights are from 10-40 g/m^2. Drying is by steam-heated cylinders or gas fired heaters. Cast coated papers are dried in contact with a smooth cylinder.

The coating mixture is prepared in the coating kitchen and screened during transfer to the coating applicator. Virtually all coating is now aqueous based.

Water: While many dyes have low toxicity, the comments in the first paragraph of Section 2.3.11 should be noted. Some dyes are potentially harmful and can have poor biodegradability and photo-degradability. They can degrade, in a biological plant, to lose colour but the degradation products may also be harmful. Metal ions are incorporated in some dyes. Solid pigments (e.g. iron oxides, carbon black) are used for high light-fastness.

Coating and the washing out of preparation tanks can have a significant impact on the ETP load. Some coaters also produce a small overflow sidestream. This is normally a fairly concentrated wastewater stream (2-10 g TSS/l). Many of the degradation products will adhere to the sludge.

Air: Not significant except where solvent based coatings lead to significant VOC releases.

Waste: Sludge - unless the wastewater solids are recovered for re-use.

Land: The separated sludge is most likely to be released to land as the incineration of this material is unattractive due to its high ash content.

Energy: The input of energy for final drying is lower than for drying the base paper due to the normally high solids content of the applied coating suspension. The specific drying energy of coated papers (GJ/tonne product) can thus be substantially lower than for uncoated papers, particularly at high coat weights. For the same reason, coating dilutes the contribution of other raw material inputs and emissions from making the base paper.

Noise: Not significant for on line coating. Off-line coaters have similar problems, to a lesser degree as paper machines.

Accidents: Chemical spillage.

Application Form Question 2.3 (cont.)

BAT for Coating is as follows:

BAT

BREF Sections: 6.3.5, 6.3.6

The main control issues are:

- Treatment of coating wastewaters - see Section 2.3.11;
- Substitution of solvents by aqueous alternatives, dyes and carriers by less harmful alternatives or those which do not inhibit the recycling of coated broke - see Section 2.2.1;
- Abatement of VOCs, where they still exist - see Section 2.3.10.

In addition:

The loss of coating materials should be minimised by:

- optimising the preparation/inventory of coating mixes using normal efficient system design/working practices and good housekeeping;
- coating losses should be monitored with a view to minimisation.

Coated broke should re-pulped and recycled to the wet end, where the coating pigment is utilised to raise the ash content of the base paper. However, the coating binder can cause deposits (white pitch) and the dispersants present in the pigment slurry can interfere with the action of wet end additives.

Where the dyes (and/or coatings) have been applied at the coating station (i.e. not in the stock), the concentration of these materials in the broke will be high. Consideration should be given to the need to wash the re-pulped broke, before returning to stock preparation, and to treat separately the concentrated washwater.

Where dyes are applied with coatings, the coating filter backwash, and the shower water and washout drains in the coating area, should be separately collected and membrane technology used to recover the coating colour. The permeate should also be recycled.

Abatement to air

2.3.10 Abatement of point source emissions to air

2.3.10.1 Nature of the emissions

Sources

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

- SO_X, NO_X, and CO_X from the combustion plant or liquor burning;
- particulates from these sources, or paper and timber handling;
- formaldehyde and ammonia from wet strength resins;
- other VOCs from:
  - the timber during mechanical pulping;
  - solvents e.g. from wire cleaning or carriers in formulated chemicals (e.g. biocides);
  - solvents for the coating processes;
- chloroform from the use of chlorine compounds in bleaching;
- odorous compounds from wet pulping areas and certain types of effluent treatment plants.

Application Form Question 2.3 (cont.)

BAT for Point Source Emissions to Air is as follows:

BAT

General techniques

The operator should 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. The operator should justify where any of the measures are not employed.

Cross-sectoral guidance on abatement techniques for point source emissions to air can be found in Ref. 9.

The operator should provide the following information with the application as appropriate. If there is any doubt, the degree of detail required should be established in pre-application discussions:

- a description of the abatement equipment for the activity;
- 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;
- measures to increase the security with which the required performance is delivered;
- measures 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;
- damage to health or soil or terrestrial ecosystems.

The applicant should demonstrate that an appropriate assessment of vent and chimney heights has been made, either here or in response to Section 4.1. Guidance is given in Technical Guidance Note D1 (see Ref. 13) and may need to be supported by more detailed dispersion modelling.

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 significant risk to health. The impact of fugitive emissions can also be assessed in many cases.

Steam plume elimination –

Releases from 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.

Cont.

Abatement to air

BAT for abatement of point sources to air (cont)

BREF Section: 4.3.10

Mechanical pulping

With reference to the release potential for VOCs from mechanical pulping described in Section 2.3.3, an assessment should be made of the options for abatement. Measurement of the emissions should be made and an assessment of the eventual fate of any condensed VOCs. VOC release (e.g. acetic acid, ethanol, terpenes, etc.) should be quantified and, where significant, a cost-benefit assessment made of the abatement options.

The fines released after pulping with the steam should be removed by a cyclone or similar.

Chemical pulping

Alkaline scrubbing of the vented gases from the digester and the digester house atmosphere can be utilised for NSSC and sulphite pulping in order to capture sulphur dioxide where problems exist.

Bleaching

Emissions of bleaching chemicals and chloroform should be minimised or captured and abated as described in Section 2.3.7.

BREF Section: 6.2.2.7

Papermaking

An assessment should be made of the quantities of formaldehyde, ammonia and other VOCs from the drying section and from re-pulping wet strength broke and the adequacy of the height of release points. Where heat recovery has yet to be installed, the impact of the various heat recovery options on VOC reduction should be made. Where any of the VOCs are Class A (see Ref. 22) substitution with less harmful alternatives should be the first option.

Coating

VOCs from solvent based coating should be collected and abated.

BREF Sections 6.4.2, 6.3.15

Combustion processes

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.

Effluent treatment

2.3.11 Abatement of point source emissions to surface water and sewer

2.3.11.1 Nature of the effluent

Summary of the activities

The nature and source of the effluent from each activity on pulp and paper mills is given in the preceding sections of 2.3. In general, in addition to the substances which give rise to the BOD of mill effluent, the wood contains organics, some of which are poorly biodegradable, and which can be particularly toxic.
A wide variety of chemicals are also used in the papermaking process and the effluent will be a complex mixture of substances. The impact of these both individually and synergistically needs to be assessed. Thus "whole sample" monitoring techniques can be appropriate - see Section 2.10.

While most pesticides and other persistent substances have been detected in releases from UK paper mills in recent years, those most frequently recorded in significant amounts are PCP, lindane, mercury and cadmium. Although concentrations tend to be low the very significant volumes of water involved mean that loadings can be high.

The use of pulps which have been bleached with chlorine can lead to releases of PCP, dioxins, furans and other chlorinated organics.

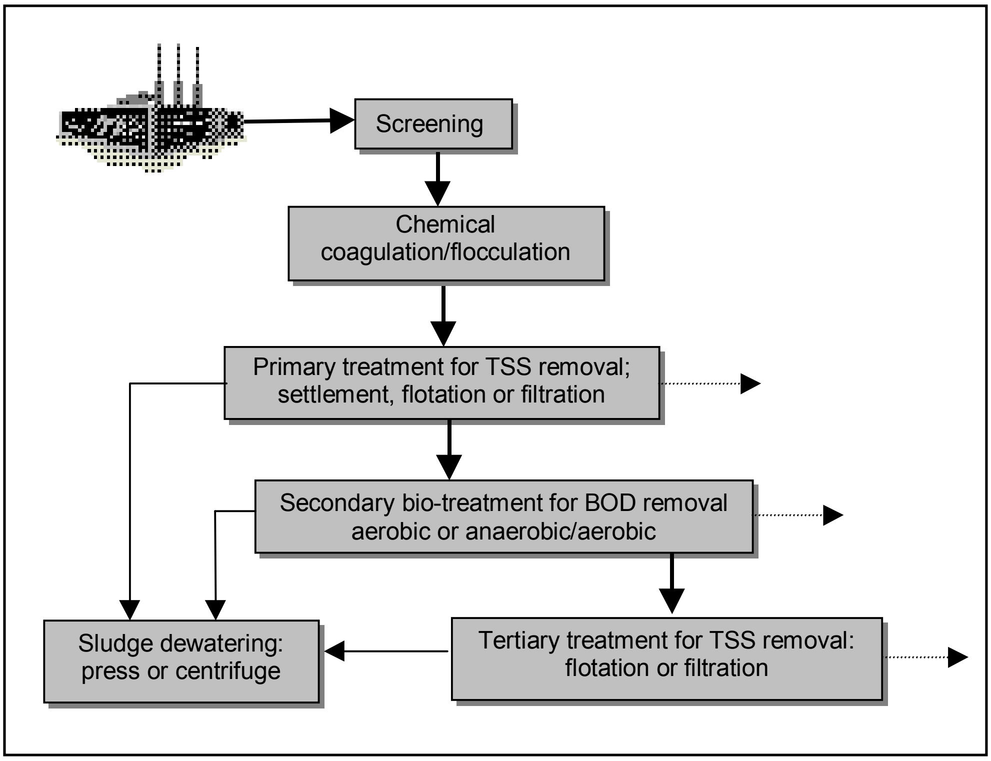
Wastewater treatment changes the nature and distribution of these substances, with some (fibre, filler, some carbon from biodegradable organics, some adsorbed organic and ions) ending up in a sludge form, others being emitted to atmosphere (some carbon from biodegradable organics, sulphur from reduced sulphates) and some remaining in the wastewater discharge (non-degraded and non-adsorbed organics, non-adsorbed and non-precipitated ions).

Wastewater can arise from the process activity, from storm water, from cooling water, from accidental emissions of raw materials, products or waste materials and from fire-fighting.

Most paper mills have some form of treatment plant prior to direct or indirect discharge. Except for its size, the nature of these plants is little influenced by the presence of integrated pulping or de-inking operations. After initial screening to remove gross solids, the wastewater may be treated in two or sometimes three stages as summarised in Figure 2.9.

In addition to the BREF and the techniques below, guidance on cost-effective, effluent treatment techniques can be found in ETBPP Guides (see Ref. 10).

Figure 2-9 - Unit Processes for Wastewater Treatment



Effluent treatment

Application Form Question 2.3 (cont.)

BAT for Effluent Treatment is as follows:

BAT for effluent treatment

The operator should describe the measures and procedures in place and proposed to prevent or reduce point source emissions to water and land. 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.

The application should include:

- a description of the wastewater treatment system for the activity including off site treatment where appropriate;
- a justification for not cleaning the effluent to a level at which it can be reused (for example by ultrafiltration where appropriate);
- the identification of 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 aquatic environment. This applies whether treatment is on or off-site;
- identification of the toxicity of the treated effluent (see Section 2.10.1.1). Until the Agency toxicity guidance is available, this should, unless already in hand, normally be carried out as part of an improvement programme.
- where there are harmful substances or levels of residual toxicity, identification of the causes of the toxicity and the techniques proposed to reduce the potential impacts;
- measures to increase the security with which the required performance is delivered;
- consideration of whether the effluent flow is sufficient to fall within the requirements of the Urban Waste Water Treatment Directive.

General water treatment techniques

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

- water use should be minimised and wastewater reused or recycled (see Section 2.2.3) in particular, uncontaminated roof and surface water, which cannot be used, should be discharged separately;
- techniques to minimise contamination risk of process or surface water should be implemented, see Section 2.3.13;
- 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 effluent by-passing the treatment plant.

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. 10).

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

Where effluent is treated off-site at a sewage treatment works, the above factors apply in particular demonstrating that:

- 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 overflows or at intermediate sewage pumping stations, is acceptably low;
- action plans in the event of bypass, e.g. knowing when bypass is occurring, rescheduling activities such as cleaning or even shutting down when bypass is occurring.
- a suitable monitoring programme is in place for emissions to sewer, taking into consideration the potential inhibition of any downstream biological processes and actions plan for any such event.

Cont.

Effluent treatment

BAT for effluent treatment (cont.)

2.3.11.2 Water Treatment for Papermaking

The following paragraphs apply to paper mills integrated with any of the other technically associated activities. Further details applicable to the other specific activities follow.

Handling

BREF Section 6.4.2

Buffer storage or balancing tanks should normally be provided to release stronger or alkaline wastewaters e.g. from machine cleaning, gradually or to provide corrective treatment, e.g. pH control and to cope with the general variability in flow and composition.

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

Primary treatment

BREF Sections 6.3.9, 6.3.11

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

- The objective of this stage is the removal of particulate solids. Settlement and dissolved air flotation systems are used at most types of mill, but filtration (usually in a rotating drum) is not widely used at present. The preferred solution will depend on the specific location and wastewater characteristics.
- Settlement systems can produce well-clarified waters, but can suffer from operating difficulties (floating solids and odour), particularly when treating stronger, warmer wastewaters. High-rate settlement units such as lamella clarifiers are used for treating specific streams such as coating wastewaters. Chemical pre-treatment (e.g. polyelectrolytes, inorganic coagulants and bentonite) is often practised to enhance the removal of colloidal solids and/or to increase settlement velocities.
- The wastewater quality achieved after primary treatment depends on many site-specific factors, but should be better than 200 mg/l TSS on most wastewaters and frequently better than 50 mg/l. There may be some removal of dissolved BOD/COD, but this is usually small (<20%) and incidental. At locations where the wastewater is discharged to sewer, there is usually no treatment beyond the primary stage.

Secondary treatment

The operator should justify the choice and performance of the plant against the following factors.

- The objective of this stage is the removal of biodegradable materials (BOD) which can be achieved by genuine degradation or by adherence of the pollutants to the sludge. The latter mechanism will also remove non-biodegradable materials such as heavy metals.
- Dioxins, furans and DDT would be expected to bind to the biomass and fibre sludge almost totally. Hexachlorobutadiene, hexachlorobenzene, aldrin, dieldrin, endrin, PCBs, trichlorobenzene and heavy metals will also be partially removed by this mechanism (mercury 40-50%, cadmium 95% and copper, chromium, lead and zinc 75-95%).
- Evidence suggests that biological treatment can remove 40% of chlorinated organics (70 -90% of chlorinated phenolics, including pentachlorophenol, in particular), by genuine biodegradation.

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

BREF Sections 4.3.12, 5.3.5, 6.3.10.

Aerobic plant is the most common biological plant, by far - plants can use air, oxygen or a combination. The use of oxygen improves control and performance and can be retrofitted to existing plants however, it would normally be preferable, on the grounds of minimising energy consumption, to size a plant to use air.

Fixed-film aerobic processes (trickling and submerged aerated filters) are used at some mills, notably where the wastewater is too weak for activated sludge treatment.

The consequences of a breakdown of the wastewater treatment plant by bulking (overproduction of filamentous bacteria) for example should be understood for the particular mill. For example the carry-over of fibre will take all the substances which are fibre substantive with it, such as cadmium and other heavy metals and many organics. In other cases the result may be little carry over of fibre but considerable quantities of dead organisms which may have less capacity for transporting other contaminants.

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

Cont.

Effluent treatment

BAT for effluent treatment (cont)

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

The operator should supply, or give the references to, the procedures which ensure that the optimum balance of added nutrients is maintained, minimising both releases of nutrients and the occurrence of overproduction of filamentous bacteria or bulking. The removal of excess nitrogen and phosphorus compounds is not normally necessary, as most papermaking wastewaters require the dosing of supplementary nutrients for biomass growth.

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. Generally aerobic, activated sludge, plants should be designed to have retention times in the order of 1 day and sludge loads below 0.15 kg BOD/kg MLSS*day in order to give high removal efficiencies, good stability and adequate breakdown of the more complex compounds present in the wastewater. Higher operating temperatures will also aid degradation. Some aerobic plants are currently planned to operate at around 30°C.

BREF Section: 5.3.5

Anaerobic treatment should be used where the conditions permit, as it will break down more ring compounds, is more effective in the removal of the chlorate which is formed in the production of chlorine dioxide, avoids problems with bulking filamentous bacteria, produces lower quantities of sludge, and produces methane which should be captured and used as an energy source. It is appropriate when the incoming organic concentrations and the temperature are high, say BOD > 2000 mg/l and 35°C. Most effluent from modern plant is of adequate temperature, and where it is not, the energy recovered from the anaerobic off-gases could be used to raise it.

The design should maximise methane production for collection and burning for energy production, noting the need to take account of other emissions such as SO_2 and NO_x..

An anaerobic system should be followed by an aerobic system as the latter achieves lower absolute release levels, will remove hydrogen sulphide and ensure that the final effluent is well aerated to assist in the breakdown of the remaining BOD. The energy gained from the anaerobic plant can be equivalent to that consumed by the aerobic plant.

The methanogenic bacteria should be protected from chlorinated and sulphur compounds, pH and temperature fluctuations and the plant made more robust by a pre-acidification stage in which other bacteria will predominate and break down many of the substances which cause the problems.

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.

Whichever design of primary and secondary plant is used, it should be able to achieve the benchmarks in Section 3. With most, relatively weak, paper mill wastewaters, levels of 5-10 mg BOD/l, 15 mg SS/l and 100 mg COD/l are common.

Tertiary treatment

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 taking the following factors into account:

- A large mill with the best primary and secondary ETP will still release 2 to 5 tonnes/day of largely unidentified substances with poor biodegradability (COD) into the local watercourse. Increasingly, the treated wastewater is being recycled to the mill in a tertiary loop for use in specific areas or after blending with fresh water. This technique allows the use of fresh water to be reduced, but without causing the problems (or gaining the benefits) of closing up internally. This is usually effected by filtration, and to a lesser degree flotation.
- Membrane or possibly evaporative plant could obviate the need for conventional abatement plant, and by generating all the fresh water needs from the recycled water, an effluent-free system can be created with fresh water make-up required only to balance evaporative losses. Studies show the lifetime costs to be similar to that of conventional biological abatement however, there are very few effluent-free plants operating and only in specific sectors such as packaging and CTMP pulp.

Cont.

Effluent treatment

BAT for effluent treatment (cont)

2.3.11.3 Options for specific mill types

Chemical pulping wastewaters are generally more concentrated and toxic than papermaking effluents and anaerobic treatment should be used for:

- pre-treatment of evaporator condensates on recovery systems (no UK examples at present);
- pre-treatment of the whole wastewater at NSSC mills without liquor burning (aerobic treatment of pulping liquors at these is possible, but high BOD removal requires more than one bio-treatment stage) - see also Section 2.3.5.

Removal of non-biodegradable, coloured lignin compounds, can be achieved by chemical adsorption/ precipitation with lime, alum and polymers, albeit with high sludge production.

Where chemical pulp making is combined with paper making, the weaker white water from the papermaking can be treated to a very low level in a separate "aerobic only" plant prior to mixing with the ex-black liquor, after it has been treated as far as reasonably practicable, for discharge.

Mechanical pulping wastewaters are always handled with those from papermaking (see above).

For non de-inked recycled mills, where the raw wastewater is of adequate quality (i.e. organic strength and temperature), anaerobic followed by aerobic bio-treatment rather than full aerobic bio-treatment would be normally be considered to be the BAT. Where this is not used in existing mills, but the wastewater is either treated aerobically or discharged for collective treatment off-site, the environmental disbenefits in terms of energy use, sludge production, discharge quality and operational stability should be quantified as part of the BAT issues.

For other de-inking/bleaching activities full biological (normally aerobic) treatment would be needed before direct discharge in view of the high COD/BOD loads from recovered paper. The operator should confirm that this is the case.

BREF Sections: 6.3.5, 6.3.6, 6.4.2

Coating wastewaters should be minimised by the techniques given in Section 2.3.9. Where they occur they should be dealt with by pre-treatment by suitable means to remove the residues of solid pigments (e.g. chemical coagulation followed by settlement) with the sludge solids being dewatered prior to disposal/re-use and the liquor handled in admixture with the paper machine wastewater.

Emulsified polyvinyl alcohol, can cause foaming and disruption of the sludge layer in the biological plant and can be treated with calcium chloride and a retention aid, in a primary settlement tank, in order to break down the emulsion and coagulate it. Although even with subsequent use of bentonite and polyacrylamide in the main settlement area, the large quantities of the material can still be a problem to the biological plant. Operators should describe how these problems are or will be overcome.

Where coloured coatings (dyes) are used, the coloured wastewaters should be separately collected and the coating materials recovered for re-use through the use of membrane technology.

Where there are still dye-related toxicity problems in the mill wastewater, an assessment should be given to the options of washing of the broke to dissolve the dye followed by separate treatment of the thickened broke filtrate and/or tertiary wastewater treatment.

Fugitives

2.3.12 Control of fugitive emissions to air

On many installations, fugitive, or diffuse, emissions may be more significant than point source emissions. Common examples of the sources of fugitive emissions are:

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

BAT

BREF Section 4.3.1

Application Form Question 2.3 (cont.)

BAT for Fugitive emissions to air is as follows:

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

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 from all sources including:

- woodyards and chipping (dust) - pulping (see Section 2.3.3) - the paper machine building (VOCs) - finishing (dust) - wastewater treatment (odour) - fuel and ash handling	- paper stores (dust, litter) - bleaching vessels (chlorine or sulphur compounds) - coating (VOCs) - broke bleaching (chlorine compounds or resin breakdown products including ammonia) - other

The operator should estimate the proportion of total emissions which 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.

Dust and litter

There should be no significant releases of dust or litter from woodyards, chipping, paper stores, finishing operations or any other part of the operation or mechanical handling. With regard to creping and finishing operations, it may be possible to control such releases by good housekeeping techniques but dust abatement equipment is likely to be needed (see Section 2.3.8). Recovered paper should be stored indoors or, if outdoors, litter must be controlled by storage in a securely fenced area with high standards of good housekeeping. The following general techniques should be employed where appropriate:

- 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.

VOCs

- 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.

Odour - see Section 2.3.14.

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

(See also Section 2.4)

BAT

Application Form Question 2.3 (cont.)

BAT for Fugitive Emissions to Water is as follows:

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

Subsurface structures

- the sources, direction and destination of all installation drains should be established and recorded;
- the sources, direction and destination of all subsurface pipework should be established and recorded;
- 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.

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;
- 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.

(# 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.)

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. 11) and (Ref.12).

There are no further issues identified for this sector.

Odour

BAT

BREF Section 6.2.2.7

2.3.14 Odour

Application Form Question 2.3 (cont.)

BAT for Odour is as follows:

Most installations in this sector have the potential for odour problems and therefore the operator should 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. SO2 releases from power plant or from a high level scrubber stack) 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**.**

(c) ***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.

Point source odour emissions are not expected unless pulping is introduced to the UK with the use of chemical recovery systems. 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. If odorous point sources do 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.

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.

Where such releases occur, they can be controlled by reducing sulphates and sulphites, the control of slime, maintaining the system pH above neutral (except machines purposely running under acid conditions), providing alternative sources of oxygen, e.g. nitrate in the ETP, and by rendering residual sulphides non-volatile by addition of iron salts.

Odour from 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.

On recovered paper mills, odour can occur, possibly from starches released in the warm water; however these are normally very localised.

These measures should be supported by a high degree of building containment, maintenance of positive airflows across doorways, extraction to combustion or other abatement systems and the use of fast closing automatic doors, such that, for a paper mill, the odour within the buildings should be contained and fall within category 2 above.

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.

Further guidance will be given in *Odour Assessment and Control – Guidance for Regulators and Industry* (see Ref. 23) along with information on dispersion design criteria. Until this guidance is available operators should use the above information and, if in doubt, discuss odour issues with the Agency.

Groundwater

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. 24). 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.

Meeting the requirements of the Groundwater Regulations

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.

There should be no direct or indirect emissions to groundwater of List I or List II substances from the installation. The operator should confirm that this is the case.

Where these cannot be confirmed the operator should 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:

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	Antimoney
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 from the machines, biocides and, possibly, pesticides in woodyards. The most likely List II substances are other biocides and any stored waste or chemical which could affect the taste or odour of groundwater.

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:

- sludges comprising mainly fibres, fillers and inks from any de-inking plant (Section 2.3.2) and the ETP (Section 2.3.11);
- bark;
- reject pulp fibres from cleaning stages and miscellaneous trash;
- boiler plant ash (some of which may be special waste);
- chemical containers and general inert industrial waste.

Application Form Question 2.5

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

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.

BAT for waste handling

General techniques for quantification, storage and handling

- 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 (this should already be available as part of waste management licence).
- Wherever practicable, waste should be segregated and the disposal route identified which should be as close to the point of production as possible.
- Records should be maintained of any waste sent off-site (Duty of Care).
- Storage areas should be located away from watercourses and sensitive boundaries e.g. adjacent to areas of public use and protected against vandalism.
- Storage areas should be clearly marked and signed and containers should be clearly labelled.
- The maximum storage capacity of storage areas should be stated and not exceeded. The maximum storage period for containers should be specified.
- 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.
- Containers should be stored with lids, caps and valves secured and in place. This also applies to emptied containers.
- Storage containers, drums etc. should be regularly inspected.
- Procedures should be in place to deal with damaged or leaking containers.
- All appropriate steps to prevent emissions (e.g. liquids, dust, VOCs and odour) from storage or handling should be taken (see Sections 2.3.10, 2.3.12 and 2.3.14).

Techniques specific to this sector

The operator should provide adequate facilities for the on-site monitoring, recording, storage, segregation, handling, loading and transportation of wastes. Sludges should be stored on an impervious surface with containment bunds and surface water drainage controls and preferably sited under cover to minimise leaching and subsequent disposal problems.

With **the application**, the operator should:

- identify and quantify the waste streams;
- identify the current or proposed handling arrangements;
- identify shortfalls in information or justifications for not using the above measures.

Post application, as described in Section 1.1, for existing installations:

- putting in place those items identified as shortfalls in the above requirements.

2.6 Waste Recovery or Disposal

BAT for waste recovery or disposal

BREF Sections: 4.3.4, 5.3.11, 6.3.14.

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.

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.

BAT for waste disposal or recovery

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 Agency needs operators to 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”.

Whether waste disposal is likely to be restricted by the implementation of the Landfill Directive should also be considered.

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 bark and sawdust recovery (if applicable) should be explored such as composting, ground cover or animal bedding (sawdust);
- All avenues for recovery of fibre and filler from de-inking and wastewater treatment sludges should be explored such as:
  - use in insulating building blocks (no current UK outlet but proven on a commercial scale in the US) operators should be encouraged to work with the insulating block companies;
  - recycling within the process or, at least, within the industry, to a wastepaper machine;
  - filler recovery (directly from sludge or from waste-to-energy ash) - options are as yet unproven on a commercial scale but have potential for significant environmental and economic benefits;
  - other commercial uses (effective fillers for plastics and rubber products, high-performance drilling muds for the oil industry, industrial adsorbents (from sludge or ash), and a particular absorbent able selectively to absorb oil from contaminated water);
  - landspreading (see Refs. 17 and 18) which should be permitted only where the operator:
    - can demonstrate that it represents a genuine agricultural benefit or ecological improvement (the pulp has little nutrient value but it can have benefits in increased water retention at root level (particularly useful in light sandy soils) and improvements in microbiological activity and soil structure);
    - 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 (although most of the heavy metals and many of the persistent organic compounds (dioxins/furans, PCP or DIPN) are removed from the water in the ETP by adhering to the sludge, levels are typically only one tenth of those found in sewage sludge);
    - 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 good practice guides). (For Northern Ireland the Codes of Practice are issued by the Department of Agriculture and Rural Development (DARD).)

BREF Sections: 5.3.10, 6.3.13.

- Where energy recovery is the chosen option for bark or sludge (where the fibre:filler ratio is high):
  - the sludge should be dewatered to the greatest practicable extent to maximise their heating value. (Screw presses can increase the solids content to 45-65% solids and then, ideally, waste process heat should be used. Alternatively, airless dryers, employing super-heated steam, may provide the most energy-efficient method of drying the sludge rapidly.);
  - the impact of burning rejects/sludges on the boiler’s energy balance should be assessed;

BAT for waste recovery or disposal (cont.)

- a new plant should be demonstrably as good as a modern, well run fluidised bed combustor in terms of flexibility in handling a variable feedstock, efficiency and emissions to atmosphere;
- residual ash from the energy recovery boiler should also be re-used;
- the plant should meet the standards in the appropriate combustion guidance.

- Where energy recovery is not appropriate the operator should:
  - assess the amount of wastes generated by nearby mills or other industrial/commercial enterprises and consider the possibility for a central, collective incineration plant;
  - consider energy recovery via an off-site plant such as a cement kiln.
- Where landfill is the only option it should be noted that, particularly when high in fillers, sludge does not readily de-water and can cause serious problems in landfill sites;
- 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.

With **the application**, the operator should:

- identify the current or proposed disposal or recovery arrangements;
- describe the current or proposed position with regard to all of the above measures;
- identify shortfalls in information or justifications for not using the above measures.

Post application, as described in Section 1.1 for existing installations:

- a detailed assessment identifying the best environmental options for waste disposal;
- implementation of any further measures identified should take place to a timescale agreed with the Agency

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, this does not preclude the consideration of energy efficiency as part of an integrated assessment of Best Available Techniques in which it may be balanced against other emissions.

Further guidance is given in the Energy Efficiency Guidance Note (Ref. 14).

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.

BAT for energy

1. Energy consumption

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 2.1 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. This information should be reported annually.

Table 2.1 - 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. Environmental emissions

In order to allow consideration of the impact of energy use, the operator should provide information on the emissions of carbon dioxide associated with the consumption of energy. This shall be carried out using the factors provided in 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.

Table 2.2 - Example summary of environmental emissions

Energy source	Annual emissions to environment of CO_2 (tonnes)
Electricity*	
Gas	
Oil	
Other	
Total	

*specify electricity by source: national grid, direct supply, on-site generation etc.

With the application, the operator should provide the consumption and emissions information required above.

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

1. Operating and maintenance procedures

The operator shall confirm and provide evidence that optimisation of operating procedures and process scheduling have been undertaken and that maintenance and housekeeping systems are in place, according to the checklists provided in Appendix 3 of the Energy Efficiency Guidance Note, in the following areas: air conditioning, process refrigeration & 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. Physical controls

The operator should identify and provide evidence that basic, low cost, physical energy efficiency techniques have been undertaken to avoid gross inefficiencies, for example:

- insulation and containment methods e.g. seals, self closing doors, to minimise losses;
- avoidance of unnecessary discharge of heated water or air e.g. by fitting simple control systems;

3. Building services

The operator should confirm that a programme of improvements will be put in place to deliver the requirements listed in 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. Identify and appraise energy efficiency measures

The operator should 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 the Environmental Assessment Methodology (see Ref. 5);

Where other methodologies have been used for appraisal, state the method or methods which are used, and provide justification for the use of these methods over those above.

This should be submitted in a summary format similar to the example below, together with supporting

This should be submitted in a summary format similar to the example below, 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 Agency will only enforce implementation of those measures in categories 1-3 above**.

Table 2.3 - 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: actual implementation will depend on other factors such as participation in CCLA, capital availability etc.

With **the application**, the operator should:

- describe the current or proposed position with regard to the above baseline measures;
- identify shortfalls in information or justifications for not using the above measures.

Post application, as described in Section 1.1 for existing installations:

- the implementation of shortfalls identified in items 1 to 4 above

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.

BAT for energy

BREF Sections:
4.3.9, 5.3.7, 6.3.8

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.

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.

- the use of partial heat recovery from the hot humid air leaving the machine drying section. It should be noted that the use of air-to-air and/or air-to-water heat exchangers can recover over 50% of the waste energy and also reduce the steam plume and VOCs which would otherwise be emitted from the machine building. Where not already employed an operator would normally be expected to provide a costed justification of different recovery levels and to assess them against the economic criteria given in Appendix 2 of the Energy Efficiency Guidance Note (Ref. 14) and in the Environmental Assessment methodology (Ref. 5);
- the use of press section designs to maximise water removal from the web and thereby reduce drying energy requirements, e.g. better materials, higher pressures and extended press nips. This application may be constrained by lack of space and inadequate strength of foundations;
- heat recovery from refiners in mechanical pulping plants;
- high consistency processes such as in bleaching and washing;
- high efficiency mechanical de-watering at all stages particularly before pulp and paper drying;
- minimisation of water use and closed circulating water systems;
- good insulation;
- plant layout to reduce pumping distances;
- phase optimisation of electronic control motors;
- using spent cooling water (which is raised in temperature) in order to recover the heat;
- belt conveying instead of pneumatic;
- For mills based on non-de-inked recycled fibre, particularly liner and fluting mills, stock preparation plant should be optimised in terms of:
  - fractionation prior to disperging (and possible refining) of the long fibre fraction;
  - improved cleaning to remove particulate contaminants;
  - washing to remove dissolved materials.

  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.
- For chemical pulping:
  - continuous pulping instead of batch,
  - indirect rather than direct evaporator heating,
  - increased liquor strength to the furnace,
  - high-consistency pulp washing,
  - converting batch processes to cold blow systems,
  - high-consistency bleaching and washing.
- optimised efficiency measures for combustion plant eg air/feedwater preheating, excess air etc
- For the following items, reference should be made to the EEBP Programme (Ref 14):

high consistency pulping and drying	high consistency forming with ultrasonics
improved rotor design	retention aids at forming
improved pulping control systems	roll and nip systems improvements
pulp cleaning cyclone improvements	impulse drying techniques

Cont.

BAT for energy (cont)

BREF Section 6.3.8

high consistency pulp screening	pre-drying humidity control
new screen designs	pre-drying hood design
refiner plate design	reducing size wetting systems
improved refiner control	final drying humidity control
ultrasonic de-aeration	final drying hood design
vacuum system heat recovery	improved calliper (thickness) control
ultrasonic forming	updated effluent plants

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.

The preferred fuel is to use waste-to-energy of sludge or bark.

BREF Sections 4.3.8, 5.3.9, 6.3.16

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. CHP makes economic sense for most mills. Mills installing CHP would normally discount such a large investment over a similar timescale to a new mill - around 15 years. Payback periods vary from 4-10 years depending upon the particular situation. Where waste-to-energy 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 use of a waste to energy scheme instead, 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.

The balance of steam demand and electricity consumption is another important factor. If the steam demand becomes too low then the economics can become less attractive. This can happen in any situation but is particularly a problem in integrated mechanical pulp and paper mills where the high consumption of electrical power in pulping and its conversion into steam via refiner heat recovery leads to a very different energy balance across the mill. This leads to the important conclusion that energy techniques must be viewed as a whole across the installation. It may, for example, be better not to reduce steam use in one part of the mill if it would prevent the installation of a CHP plant with better overall environmental performance.

BREF Section 4.3.11

The operator should demonstrate that the option of energy recovery from incineration of process waste has been considered and should justify any decision not to recover energy. Similar cost assessment considerations would apply. Co-incineration or schemes with other operators should be considered.

Reasons for not being able to justify a waste-to-energy plant might be that the waste is already being put to more beneficial use or that the sludge has a low combustible content (some sludges are high in filler and low in fibre) or that a gas powered CHP plant offers better overall performance even though it is using fossil fuels. The two alternatives have considerable impact on other pollutants and the assessment should take into account air and waste emissions balanced against the costs.

BREF Sections 6.4.2, 6.3.15

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 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.

Where NO CCL Agreement in place or where wider BAT issues are relevant:
With the application the operator should supply: • the current or proposed position with regard to the above measures; • identify shortfalls in information or justifications for not using the above measures.
Post application, as described in Section 1.1 for existing installations: • the provision of shortfalls identified in information; • implementation of any further measures identified should take place to a timescale agreed with the Agency

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.

Some installations will also be subject to the Control of Major Accident Hazards Regulations 1999 (COMAH) (see Appendix 2 for equivalent legislation in Scotland and Northern Ireland). 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.

The COMAH regime applies to major hazards. For accident aspects covered by COMAH, reference should be made to any reports already held by the Agency. 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. 19), 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.

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.

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.

2.8.1 Identifying the hazards

BAT for control of accidents

The operator should 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);
- overfilling of vessels;
- failure of plant and/or equipment (e.g. over pressure of vessels and pipework, blocked drains);
- 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; and
- vandalism.

2.8.2 Assessing the risks

Having identified the hazards, the risks should be assessed. This process 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).

Cont.

BAT for control of accidents (cont)

BREF Sections

The depth and type of assessment will depend on the characteristics of the installation and its location. The main factors that 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 of deciding and justifying the adequacy of the risk control techniques.

2.8.3 Techniques to reduce the risks

The operator should describe techniques to prevent accidents and minimise their environmental consequences including, but not limited to, the techniques described below.

General techniques

- an inventory should be established 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 Agency 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, passing valve control, tank level readings, e.g. 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, catchpots, building containment;
- 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;
- adequate redundancy or standby plant should be provided with maintenance and testing to the same standards as the main plant;
- 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;
- 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;
- 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.

Cont.

BAT for control of accidents (cont)

- 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. 15 and 16);
- 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;
- the systems for the prevention of fugitive emissions are generally relevant (Sections 2.3.12 and 2.3.13) 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 with 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 for ensuring 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.

Sector specific techniques

BREF Sections: 6.3.7- 6.3.9, 6.4.2

- For paper machines, and on-line coating, accidental and unnecessary discharges, particularly on web breaks, should be controlled by:
  - on-line monitoring of key machine functions for forewarning;
  - on-line monitoring or manual sampling/analysis of drain flows/suspended solids to establish baseline for normal losses;
  - designing the broke system with sufficient capacity to avoid overflow and loss of water and fibre to the ETP;
  - designing the whitewater tanks with sufficient capacity for repulping this quantity of broke;
  - computer control of the system taking into account the production schedule and the levels of the white water, broke and pulp towers (i.e. the system inventories);
  - separate broke and white water systems for each machine, especially where machines are producing different, incompatible grades;
  - interlocking of chemical dosing pumps with machine operation in order to prevent continued dosing after machine stoppage.
- 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.
- Techniques against the spillage of volatile compounds - formaldehyde, solvents or organic coatings.
- The operator should define the maximum quantity of coated broke allowed in different grades and describe the measures which are, or will be, in place, to ensure that this is not exceeded. The storage capacity for coated broke stock should be sized accordingly.
- Systems should be in place to ensure that bypass cannot take place of the ETP. Releases should not take place to sewer where storm overflows are likely. See Section 2.3.11.

With **the application**, the operator should:

- describe the current or proposed position with regard to all of the above measures;
- identify shortfalls in information or justifications for not using the above measures;
- identify of any issues which may be critical.

Post application, as described in Section 1.1 for existing installations:

- a structured accident management plan;
- implementation of any further measures identified to minimise accident risk should take place to a timescale agreed with the Agency

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. 20) 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.

Your response should cover all relevant issues pertinent to your installation. In doing so you should justify your proposals against any expectations expressed in that guidance.

Information needed to determine BAT for noise and vibration

BREF Section 6.2.2.8

Existing noise situation

The operator should provide information on the following:

1. ***The main sources of noise and vibration*** that fall within the IPPC installation, providing the following information for each source:

- whether continuous/ intermittent;
- the hours of operation;
- the type, e.g. aural or vibrational, impulsive 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. For example, 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. ***Infrequent sources of noise and vibration*** not listed above (such as infrequently operated/ seasonal operations, cleaning/maintenance activities, on-site deliveries/collections/transport or out-of-hours activities), providing the information required in (1) for each source plus its times of operation.

3. ***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 showing grid reference, nature of the receiving site, distance and direction from site boundary;

Cont.

Information needed to determine BAT for noise and vibration (cont.)

(b) conditions/limits imposed which relate to other locations (i.e. boundary fence or surrogate for nearest sensitive receptor):

- any conditions imposed by the Local Authority (day/evening/night*);
- other conditions imposed, e.g. limits on operating times, technologies etc.

(c) the noise environment:

- background noise level, if known (day/night/evening) LA,90,T;
- specific noise level (day/evening/night) LA eq, T; and/or
- ambient noise level (day/evening/night) LA eq,. T, as appropriate;
- vibration data which may be expressed in terms of the peak particle velocity (ppv) or the vibration dose value (VDV).

These are given the meaning as defined in BS4142 "*Method for rating industrial noise affecting mixed residential and industrial areas"*, and to which reference should be made for a full description. 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. Details of any environmental noise measurement surveys, any noise modelling work 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.

BAT for control of noise and vibration

BREF Section: 6.3.19

Noise control techniques

Case studies are given in the BREF.

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.

Most installations in this sector have the potential for noise problems and therefore the operator should maintain a Noise Management Plan**.** Noise surveys, measurement, investigation or modelling may be necessary for either new or existing installations depending upon the potential for noise problems.

Debarking and chipping
While debarking noise can be dealt with, in most cases, by the careful location of plant or by relatively simple shielding, the chipping operations are extremely noisy. If placed indoors, acoustic design of the building structure and doors will be needed. An alternative, which is in operation in the UK, is to place both the chipper and the conveyors underground, thereby also solving the dust problems.

Refiners
Refiners in mechanical pulping are also inherently noisy. They should be sited indoors and the comments under papermaking will apply.

Paper making
The main external noise sources are:

- process ventilation;
- machine room ventilation;
- vacuum pump exhaust (typically 100 dB(A) at 1 m).

Cont.

BAT for control of noise and vibration (cont.)

BREF Section: 6.3.19:

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.

The paper machine itself is inherently noisy because of the large number of moving parts. The BREF gives details of noise levels around paper machines before and after maintenance showing the importance of maintenance as a noise control technique. Newer machines are also quieter, but 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.

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
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
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
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. The BREF shows a typical cost curve for external attenuation showing a sharp increase in the cost per dB attenuated in this sector below 65 dB(A). See Ref 20 for guidance on balancing costs and benefits in this area.

With **the application**, the operator should:

- provide the information required above;
- identify any specific local issues and proposals for improvements.

Post application, as described in Section 1.1 for existing installations:

- a noise management plan , noting that this may be required earlier if there are local problems;
- implementation of any further measures identified to minimise noise should take place to a timescale agreed with the Agency.

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.

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.

2.10.1 Emissions monitoring

Emissions monitoring

BREF: Monitoring REF document in preparation.

The following monitoring parameters and frequency are normally appropriate in this sector. The operator should confirm that this is so or justify any alternative arrangements. Generally monitoring should be undertaken during commissioning, start-up, normal operation, and shut-down unless the Agency 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.

2.10.1.1 Monitoring and reporting of emissions to water and sewer

Monitoring of process effluents released to controlled waters and sewers should 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.

BOD/ADt and COD/ADt should be established annually as an annual average.

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 Agency that they are not applicable. This should normally be done at least annually.

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.

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. 21) and the Agency will be providing further guidance in due course. Except in special circumstances toxicity testing should await that guidance.

AOX - Absorbable Organic Halogen - is often used worldwide in this industry as a collective, and sometimes surrogate, measure of specific chlorinated substances, although it is not normally applicable in the UK unless the release is greater than 50 g/t.

Cont.

Emissions monitoring (cont.)

2.10.1.2 Monitoring and reporting of emissions to air

There are typically a large number of vents to atmosphere from papermaking plants. The operator should identify the substances which will be released from each, and quantify them, to enable the Agency to determine which, if any, will require regular monitoring. Although dependant 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
Formaldehyde or ammonia released from dryers and from broke repulping on machines using UF/MF wet strength resins	Quarterly
Chlorinated organics, chloroform, chlorine or chlorine dioxide generated when chlorine or hypochlorite are used for broke bleaching	Quarterly
VOCs from paper machine drying sections, coating, and mechanical pulping	Quarterly
Oxides of sulphur from sulphite or NSSC pulping	Continuous where release is significant or controllable
Combustion emissions	See separate Guidance

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

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

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

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.

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.

2.10.1.3 Monitoring and reporting of waste emissions

For waste emissions the following should be monitored and recorded

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

2.10.2 Environmental monitoring (beyond the installation)

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 when, for example:

- 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 paper mills in the UK discharging to controlled waters environmental monitoring programmes are usually needed.

Cont.

Environmental monitoring (cont.)

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;
- 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. 21), for noise (Ref. 20) and odour (Ref. 23).

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:

- On UK pulp and paper mills only the 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. 23).

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 20 - Noise Regulation, Measurement and Control.

Cont.

Monitoring process variables

BREF Section: 6.3.8

2.10.3 Monitoring of process variables

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.

- Raw materials monitoring for contaminants where contaminants are likely and there is inadequate supplier information (see Section 2.2.1).
- Chlorinated organic compounds in bought-in pulps bleached with chlorine or hypochlorite.
- Dissolved organics in bought-in pulps where pulp accounts for more than 50% of total wastewater COD.
- Harmful substances (e.g. cadmium and other heavy metals and PCP) in recovered paper where there is a need to establish the source. See below for sampling strategies:
- Wire retentions of fibre and, where present, filler to determine appropriate control strategies for minimising waste and the load on the ETP.
- Save-all efficiency to establish the performance of the plant with regard to minimising waste and the load on the ETP
- Energy consumption across the mill and at individual points of use in accordance with the energy plan.
- Fresh water use across the mill and at individual points of use as part of the water efficiency plan (see Section 2.2.3).
- Recycled water quality and circuit overflows as part of the water efficiency plan (see Section 2.2.3).
- Water levels of broke and white water tanks should be continuously monitored and alarmed to minimise the frequency of accidents and develop an accident control strategy (see Section 2.8).

2.10.4 Monitoring standards (standard reference methods)

2.10.4.1 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.

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 21) for listing of MCERTS equipment

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 Agency;
- 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.

Cont.

Standards for sampling and analysis

BREF: Monitoring REF document in preparation.

2.10.4.2 Sampling and analysis standards

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. 21). 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.

With **the application**, the operator should:

- Describe the current or proposed position with regard to all of the requirements above, for emissions monitoring, environmental monitoring, process monitoring (where environmentally relevant) and monitoring standards employed;
- Identify shortfalls in information or justifications for not using the listed requirements.

Post application, as described in Section 1.1 for existing installations:

- provision of identified shortfalls of information;
- implementation of any further measures identified to improve monitoring should take place to a timescale agreed with the Agency.

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).

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.

BAT for de-commissioning

Steps to be taken at the design and build stage of the activities

Decommissioning should be considered at the design stage of any new development to increase the ease and security of decommissioning. For existing installations, where potential problems are identified, a programme of improvements should be put in place. 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 are used which are readily recyclable (where this does not conflict with operational or other environmental objectives).

The site report and operations during the IPPC permit

The IPPC application requires the preparation of a site report to provide a point of reference against which later determinations can be made of whether there has been any deterioration of the site under IPPC and also information on the vulnerability of the site. More detail on the purpose, and the method of carrying out the work are described in Refs. 3 and 4.

Operations should not lead to deterioration of the site if the requirements of this note is 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 annually with the emissions inventory information.

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 order and timing of the closure of the various parts of the installation 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;
- the lodging of plans of all underground pipes and vessels with the Agency and the method by which they will be kept up to date;
- the method and resource necessary for the clearing of lagoons;
- the method of ensuring that any on-site landfills can meet the equivalent of surrender conditions;
- the removal of asbestos or other potentially harmful materials unless agreed that it is reasonable to leave such liabilities to future owners;
- methods of dismantling buildings and other structures – see Ref 25 which gives guidance on the protection of surface and groundwater at construction and demolition-sites;
- the 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.)

With **the application**, the operator should:

- Describe the current or proposed position with regard to all of the above measures;
- Identify shortfalls in information or justifications for not using the listed requirements
- supply the site report (as described in the Application Form) and, for a new installation, a description of how the design has taken into account final closure as required above.

Post application, as described in Section 1.1 for existing installations:

- provision of identified shortfalls of information;
- implementation of any further measures identified to minimise risks from decommisioning should take place to a timescale agreed with the Agency.

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.

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.

BAT for installation wide issues

Where there are a number of separate permits forming the installation (particularly where there are different operators), the operator should identify any installation wide issues whereby the performance of the overall installation may be improved by interactions between the operators.
The possibilities will be both sector and site-specific; and include:

- communication procedures between the various permit holders; in particular those needed to ensure that the risk of environmental incidents is minimised;
- benefiting from the economies of scale to justify the installation of a CHP plant;
- the combining of combustible wastes to justify a combined waste-to-energy/CHP plant;
- the waste from one activity being a possible feedstock for another;
- the treated effluent from one activity being of adequate quality to be the raw water feed for another activity;
- the combining of effluent to justify a combined or upgraded effluent treatment plant;
- the avoidance of accidents from one activity which may have a detrimental knock-on effect on the neighbouring activity;
- land contamination from one activity affecting another - or the possibility that one operator owns the land on which the other is situated.

With **the application**, the operator should identify the essential communication needs between the permit holders and should briefly identify any apparent opportunities for further interactions between the permit holders and identify shortfalls in information.

Post application, as described in Section 1.1 for existing installations:

- provision of identified shortfalls of information;
- the site closure plan;
- report(s) into the viability of installation wide options
- implementation of any further measures identified to improve overall installation performance should take place to a timescale agreed with the Agency.

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).

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.

Table of Emissions

A list or table should be provided 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;
- 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);
- point source emissions to air;
- significant fugitive emissions to all media;
- abnormal emissions from emergency relief vents, flares etc.

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.

Comparison with Benchmarks

The emissions should meet the benchmark values given, revisiting the responses made in Section 2 as appropriate (see Section 1.2).

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.**

EC based EQ Standards

IPPC: A Practical Guide (see Ref 3) 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)

3.2.2 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.

3.2.3 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.

3.2.4 Reference conditions for releases to air

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. 21) for more information.

3.3 BOD

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

BREF Tables: 2.41, 3.16, 4.15, 4.17, 5.30, 5.32, 6.29, 6.31

Activity	**BREF Benchmark values (Yearly Averages)**			
	Pre treatment	**Post treatment**		
	kg/ADt	**kg/ADt**	**Water Flows m^3/ADt**	**mg/l calc.**
Mechanical pulp integrated with newsprint, LWC or Supercalendered or 50% RCF/50% Mechanical pulp	8-12	0.2-0.5	12-20	10-40
RCF not de-inked i/g cartonboard, testliner etc		0.05-0.15	<7	7-21
RCF de-inked i/g Newsprint or printings / writings covered fibre De-inked	8-12	0.04-0.2	8-15	2.5-25
RCF Tissue	8-12	0.05-0.4	8-25	2-50
Fine paper coated or uncoated not integrated	1-2.5	0.15-0.25	10- 15	10-25
Tissue non integrated		0.15-0.4	10-25	6-40
Integrated NSSC			2.5-5	
Other speciality integrated pulping mills & speciality papers		0.15-1.3	15-50 (Note 1)	
Sulphate pulp unbleached for comparison	6-9	0.2-0.7	15-25	8-47
Sulphate pulp bleached for comparison	13-19	0.3-1.5	30-50	

Note 1 - the specific water consumption sometimes exceeds 100 m^3/ADt

The BOD benchmarks pre treatment are important as a measure of mill performance especially where the effluent is to be treated off-site.

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 is therefore of paramount importance. 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.

An alternative reason for higher concentrations, at least for a limited period, is where a programme of improvements reduces mass discharge by closing up water systems flow but goes beyond the current ability of the treatment plant to deliver low concentration levels.

3.4 COD

Other Applicable Standards and Obligations

None

Benchmark Emission Values

BREF Tables: 2.41, 3.16, 4.15, 4.17, 5.30, 5.32, 6.29, 6.31

Activity	BREF Benchmark values (Yearly Averages)			
	Pre treatment	Post treatment		
	kg/ADt	kg/ADt	Water Flows m^3/ADt	mg/l calc.
Mechanical pulp integrated with newsprint, LWC or Supercalendered or 50% RCF/50% Mechanical pulp	9-18 (up to 90 if peroxide bleached)	2-5	12-20	100-420
RCF not de-inked i/g cartonboard, testliner etc		0.5-1.5	<7	70-210
RCF de-inked i/g Newsprint or printings / writings covered fibre De-inked	18-23	2-4	8-15	130-500
RCF Tissue	18-50 depending on waste grade	2-4	8-25	80-500
Fine paper coated or uncoated not integrated	1-9 primary treated	0.5-2.0	10-15	40-200
Tissue non integrated	1-2.2 primary treated	0.5-2.0	10-25	20-200
Integrated NSSC			2.5-5	
Other speciality integrated pulping mills & speciality papers		0.4-7.0	15-50 (Note 1)	
Sulphate pulp unbleached for comparison		5-10	15-25	200-630
Sulphate pulp bleached for comparison		8-23	30-50	

Note 1 - the specific water consumption sometimes exceeds 100 m^3/ADt

The ratio of BOD to COD can vary from mill to mill, by a factor of 10, depending on the substances used.

By its nature, "hard" COD is partially removed by primary treatment but is not degraded in a biological plant. The value of COD will depend (more than is the case for BOD) upon the effectiveness of the techniques to reduce the loss of materials to the wastewater. On installations that carry out chemical pulping or bleaching which deliberately dissolves lignin, these inputs will dominate.

The calculated concentration is the simple ratio of the kg/ADt and flow ranges. However, the higher figures in the ranges are not generally found in practice. This is because those mills with greatest closure will also be those which have gained the benefits of closure in terms of minimising mass release; i.e. those mills with the lowest flow will also tend to have the lower COD mass releases. Values are typically 25% lower than shown as a result.

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.

It is appreciated that an exhaustive speciation of the COD could become very expensive for each mill but, by an intelligent understanding of the process, the majority components should be identifiable and confirmed by analysis. Mills of similar types are encouraged to exchange information on these aspects and work together on analysis. As yet there is no clear picture of the nature of the COD released from different categories of mill. This stresses the importance of measures to reduce releases and increases the emphasis on precaution when assessing the options for tertiary treatment, see Section 2.3.11.

Where limits are set, because closing up water systems increases concentrations, they should be load-based, or at least derived from a load-based assessment.

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)	Chloroform	PCP
		mg/l annual average	
Designated freshwaters SI 1997/1331			
Salmonid imperative: guideline:	0.005 -		
Cyprinid imperative: guideline:	0.005 -		
Dangerous Substances List 1 (Fresh or tidal)		12	2

Benchmark Emission Values

Media	Substance	Activity	Benchmark value	Basis for the Benchmark
To air	Chloroform	Bleaching/ broke recovery (2.3.7)	5 mg/m^3	Parity with UK chemical sector (Note 1)
To air	Chorine		5 mg/m^3	
To air	Chlorine dioxide		1 mg/m^3	
To water	Pentachlo-rophenol	Bleaching or incoming recovered paper	1 µg/l	Previous IPC Benchmark, based on removal in good ETPs. (Note 3)
To water	AOX	Mills using wet strength agents	10 g/ADt 1mg/l @ 10m^3/ADt 0.4 mg/l @25m^3/ADt	(Note 2)
		Other mills	5 g/ADt	
To air	Dioxins		see VOCs	
To air	HCl and HF	Combustion / incineration	See appropriate guidance (Ref 14)	

Notes:

1. Chlorine bleaching should have been phased out.

2. AOX (absorbable organic halogen) is a measure, used widely in this industry, which includes the more harmful, highly substituted chlorinated organics, such as PCP, as well as those with lesser substitution as long as they are absorbable. It was the main measure in the drive away from chlorine bleaching.

   Below a level of around 1.5 kg/ADt the correlation of AOX level with toxicity or harm becomes harder to demonstrate. There are no mills in the UK which release AOX at such levels. Most mills in the UK release less than 5 g/ADt, although some sectors, such as tissue making, use chlorine based wet strength agents which will increase AOX although with lower substituted compounds. Tissue mills should not exceed 10 g/ADt.

   It is not normally necessary to set AOX limits in permits, except where there is a programme to reduce them by in process techniques, as the other controls on the ETP will otherwise determine the levels.

3. PCP is not deliberately used but can be minimised by reducing any use of hypochlorite. The phenol content of the incoming water may be a factor.

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 2.9), 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	timber, inks and dyes and are most significant in de-inking.	0.1 µg/l	Parity with other sectors
To water	Cadmium		0.6 µg/l	
To Air	Heavy metals	Combustion /incineration	See appropriate guidance (Ref 14)	

Note: The actual levels achieved after abatement are often not detectable. For figures which are quantifiable with an adequate degree of confidence in typical treated, paper mill effluent, see Table A1.2 in Appendix 1.

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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 NO_x.

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

Benchmark Emission Values

Media	Activity	Benchmark value		Basis for the Benchmark
		Mass release	Concentration	
To air	from liquor burning	No UK applications. See BREF for details if required		Will require the use of good combustion chamber design and low NO_x burners.
To air	from energy recovery of bark or sludge	60-80 mgNO_x/MJ fuel input	200 mg/m^3 where Waste Incineration Directive applies. Otherwise see appropriate guidance note (Ref 14).	Mass value is a BREF value - calculated, with no control. Value reduces to 40-60 with SNCR. Concentration is based on Waste Incineration Directive
To air	from combustion plant		See appropriate guidance note (Ref 14)	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

In most cases there is no nitrogen or phosphorus in the raw wastewater, it all comes from dosing in the ETP. Activated sludge plants in particular need a residual level of nutrients to avoid bulking problems. The above figures are guidelines but it is more important that procedures are in place to ensure that there is minimum residual nutrients while maintaining the health and security of the effluent treatment plant. The environmental effects of failure to maintain this balance can outweigh the benefits of a slight reduction in nutrients released.

Dosing is dependent on the raw BOD and the residual will be also to some degree, particularly where the BOD is very variable. Account must be taken of nitrate or phosphate vulnerability of the receiving environment.

BREF Tables: 2.41, 3.16, 4.15, 4.17, 5.30, 5.32, 6.29, 6.31

Activity	BREF Benchmark values (Yearly Averages)			
	Pre treatment	Post treatment		
	kg/ADt	N total kg/ADt (mg/l)	Water Flows m^3/ADt	P total kg/ADt (mg/l)
Mechanical pulp integrated with newsprint, LWC or Supercalendered or 50% RCF/50% Mechanical pulp (Note 2)	Pre treated values are not relevant as both nutrients are added at the effluent treatment stage. Some N_2/ammionia may be present before treatment from breakdown of wet strength agents	0.04-0.1 (2.5-5)	12-20	0.004-0.01 (0.5-1)
RCF not de-inked i/g cartonboard, testliner etc. (Note 3)		0.02-0.05	<7	0.002-0.005
RCF de-inked i/g Newsprint or printings / writings covered fibre De-inked		0.05-0.1	8-15	0.005-0.01
RCF Tissue		0.05-0.25	8-25	0.005-0.015
Fine paper coated or uncoated not integrated		0.05-0.2 (10)	10 – 15	0.003-0.01 (2)
Tissue non integrated (Note 4)		0.05-0.25 (10)	10-25	0.003-0.015 (1)
Integrated NSSC			2.5-5	
Other speciality integrated pulping mills & speciality papers		0.15-0.4	15-50 (Note 1)	0.01-0.04
Sulphate pulp unbleached for comparison		0.1-0.2	15-25	0.005-0.02
Sulphate pulp bleached for comparison		0.1-0.25	30-50	0.01-0.03

Note 1 the specific water consumption sometimes exceeds 100 m^3/ADt.

Note 2 For integrated mechanical pulp mills there are no raw wastewater nutrient loads and the BOD is relatively constant.

Note 3 For RCF packaging mills there can be nitrogen from urea based wet strength agents (where used) and the BOD is high and variable.

Note 4 For tissue there will be nitrogen from dye/OBA use and breakdown of urea based wet strength agents. At low BOD virgin pulp mills this may be enough to avoid the need for nitrogen dosing. This would not apply to de-inked tissue.

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

BREF Tables: 2.41, 3.16, 4.15, 4.17, 5.30, 5.32, 6.29, 6.31

To Water - Activity	BREF Benchmark values (Yearly Averages)			
	Pre treatment	Post treatment		
	kg/ADt	kg/ADt	Water Flows m^3/ADt	mg/l calc.
Mechanical pulp integrated with newsprint, LWC or Supercalendered or 50% RCF/50% Mechanical pulp		0.2-0.5	12-20	10-40
RCF not de-inked i/g cartonboard, testliner etc		0.05-0.15	<7	7-20
RCF de-inked i/g Newsprint or printings / writings covered fibre De-inked		0.13-0.3	8-15	14-37
RCF Tissue		0.1-0.4	8-25	4-50
Fine paper coated or uncoated not integrated		0.2-0.4	10 - 15	13-40
Tissue non integrated		0.2-0.4	10-25	8-40
Integrated NSSC			2.5-5	
Other speciality integrated pulping mills & speciality papers		0.3-1.0	15-50 (Note 1)	6-75
Sulphate pulp unbleached for comparison		0.3-1.0	15-25	12-75
Sulphate pulp bleached for comparison		0.6-1.5	30-50	12-50

Note 1 the specific water consumption sometimes exceeds 100 m^3/ADt

As with COD, the higher, calculated concentration figures in the ranges are not generally found in practice because those mills with greatest closure will also be those which have gained the benefits of closure in terms of minimising mass release; i.e. those mills with the lowest flow will also tend to have the lower suspended solids mass releases. Values are typically 25% lower than shown as a result.

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. For example the reduction of TSS comprising mainly filler (calcium carbonate) into an estuarine situation typically containing vast quantities of calcium carbonate from marine life may show little environmental benefit. 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 storage yards and materials handling (2.3.12)	"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 paper finishing activities (2.3.12)	50 mg/m^3	
Point release from liquor burning		Will require bag filters or precipitators.
Point release from mechanical pulping	50 mg/m^3	Assumes cyclone separation of fibre fines
Point release from combustion plant/incineration	See appropriate guidance note (Ref 14)	See appropriate guidance note Based on parity with other sectors

3.10 Sulphur Dioxide

Other Applicable Standards and Obligations

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

Statutory Instrument 1989 No 317, *Clean Air, The Air Quality Standards Regulations 1989* gives limit values in air for sulphur dioxide.

Statutory Instrument 1997 No 3043, *Environmental Protection, The Air Quality Regulations 1997* gives air quality objectives to be achieved by 2005 for sulphur dioxide

The UNECE convention on long-range transboundary air pollution. Under this Convention, a requirement further to reduce 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 liquor burning	No UK applications. See BREF for details if required		Will require the use of wet scrubbing or lime injection.
To air	sodium hydrosulphite bleaching (2.3.7)		no values available	control of pH and temperature.
To air	from energy recovery of bark or sludge	5-10 mgS/MJ fuel input	See appropriate guidance note (Ref. 14)	BREF value - calculated. No control.
To air	from combustion plant		See appropriate guidance note (Ref. 14)	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. The coating of paper is covered and the emission limits are as follows:

Consumption of the compound	Emission concentration mg/m^3 as carbon
5 – 15 t/yr	100
>15 t/yr	50 for drying operations 75 for coating applications

"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. Although Pulp and Paper is included in the "other miscellaneous industries" sector, no specific reduction targets are 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
Formaldehyde	Papermaking wet strength agents (2.3.8)	emission >100 g/h	20 mg/m^3 as formaldehyde	Parity with other UK industrial sector benchmarks for a Class A VOC.
Solvents (various). e.g. from wire cleaning or carriers in formulated chemicals, e.g. biocides.	Papermaking, (particularly at recycled mills) (2.3.8)	emission > 5 t/yr	80 mg/m^3 as toluene	Parity with other UK industrial sector benchmarks
Solvents (various) for coating formulations	Coating (2.3.9)	emission > 5 t/yr	80 mg/m^3 as toluene	The lower of these levels should be used to ensure: • Parity with other UK industrial sector benchmarks • The meeting of the Directive.
		consumption > values in Solvents Directive above	"Solvent Directive" levels as carbon	
Volatile wood compounds (e.g. acetic acid, fatty acids, formic acid, resin acids, turpentine, ethanol, methanol.)	Mechanical Pulping (2.3.3)	emission > 1kg in any 24h period.	50 mg/m^3	
Dioxins	Liquor burning		1 ng/m^3	Parity with other UK industrial sector benchmarks.
PAHs			0.1 mg/m^3	
VOCs			20 ng/m^3	
VOCs and dioxins	Other combustion /incineration		See appropriate guidance (Ref. 14)	

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.

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.

The operator should assess that the emissions resulting from the proposals for the activities/installation will provide a high level of protection for the environment as a whole, in particular having regard to EQSs etc, revisiting the techniques in Section 2 as necessary (see Section 1.2).

Assessment Steps

- 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.
- 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, 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.
- Identify the pathways by which the receptors will be exposed (where not self evident).
- 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 (see 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.
- 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, 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.

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.ehsni.gov.uk. Most titles will also be available in hard copy from The Stationery Office (TSO). Some existing titles are not yet available on the Website but can be obtained from TSO.

1. IPPC Reference Document on Best Available Techniques in the Pulp and Paper Industry European Commission http://eippcb.jrc.es.
2. The Pollution Prevention and Control Regulations (2000: SI 1973).
3. IPPC: A Practical Guide (DETR for England and Wales) (or equivalents in Scotland and Northern Ireland).
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 E2).
6. Management system references:
    - ETBPP, Environmental Management Systems in Paper Mills GG51, ETBPP Helpline 0800 585794.
7. Waste minimisation references:
    - Environment Agency Website. Waste minimisation information accessible via: www.environment-agency.gov.uk/epns/waste;
    - **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.
8. Water efficiency references:
    - ETBPP, Water use in UK Paper and Board Manufacture, EG69;
    - ETBPP, Practical Water Management in Paper and Board Mills, GG111;
    - ETBPP, Employee's ideas Save Water (Kimberley Clark) CH132;
    - 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.
9. Air Abatement references:
    - A3 Pollution abatement technology for particulate and trace gas removal 1994 £5.00 0-11-752983-4 (W summary).
10. Water Treatment references:
    - A4 Effluent Treatment Techniques, TGN A4, Environment Agency, ISBN 0-11-310127-9 (W summary);
    - ETBPP, Cost Effective Effluent Treatment in Paper and Board Mills, GU156;
    - 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;
    - Treatment in Paper and Board Mills, GU156.

11. 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. (W)
12. 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 on line purchase).
13. Dispersion Methodology Guide D1 (W summary).
14. 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;
    - Part B PG1/3 Boilers and Furnaces 20-50 MW net thermal Input (ISBN 0-11-753146-4-7);
    - Part B PG1/4 Gas Turbines 20-50 MW net thermal Input (ISBN 0-11-753147-2).
15. BS 5908: Code of Practice for Fire Precautions in the Chemical and Allied Industries.
16. 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 (W).
17. 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.
18. Agency guidance on the exemption 7 activity, proposed.
19. 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; (W);
    - 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.
20. Assessment and Control of Environmental Noise and Vibration from Industrial Activities – (Joint agencies guidance in preparation).
21. Monitoring Guidance (W):
    - 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.
22. The Categorisation of Volatile Organic Compounds. DOE Research Report No DOE/HMIP/RR/95/009 (W).
23. Odour Assessment and Control – Guidance for Regulators and Industry. (Joint agencies guidance in preparation).
24. "Policy and Practice for the Protection of Groundwater" (PPPG) (W).
25. Working at Construction and Demolition-sites (PPG 6) (W).

DEFINITIONS

ADt	Air dried tonne of paper (paper contains around 7% water under ambient conditions)
AOX	Adsorbable Organic Halogen
APP	Alkaline peroxide process
BAT	Best Available Techniques
BAT Criteria	The criteria to be taken into account when assessing BAT, given in Schedule 2 of the PPC Regulations
BOD	Biochemical Oxygen Demand
Broke	Paper made on the machine and returned to the process for a variety of reasons but usually because of web breaks
CHP	Combined heat and paper plant
Closed-water	The water is repeatedly recycled with the minimum of losses)
COD	Chemical Oxygen Demand
Couch-pit	Under, and at the end of the wire this collects the deckle trim and wire broke
CMC	Carboxymethycellulose
CTMP	Chemi-thermo-mechanical-pulping processes (using sulphite or APP)
DAF	Dissolved air flotation
Deckle	The edge of the paper continuously trimmed off the web and returned to the stock
DTPA	Diethylene triamino pentaacetic acid
ECF	Elemental chlorine free (pulp bleached without elemental chlorine)
EDTA	Ethylene diamine tetra-acetic acid
EMS	Environmental Management System
ETP	Effluent treatment plant
Fibrillate	Raising small hairs on the fibres which increase their bonding strength
Fourdrinier	The most common design of paper-making machine comprising a wire forming section, a press section and a drying section as shown in Figure 5
Furnish	The diluted pulp, fillers and other additives fed to the machine
Integrated-mill	A mill in which both pulping and paper-making take place
ITEQ	International Toxicity Equivalents
Machine	A paper-making machine
MF	Melamine formaldehyde
MLSS	Mixed Liquor Suspended Solids
NIEHS	Northern Ireland Environment and Heritage Service
NTA	Nitrilo triacetic acid
PAE	Polyamidoamine-epichlorhydrin resins
PAM	Polyacrylamides
PCDD	Poly chlorinated dibenzo dioxins
PCDF	Poly chlorinated dibenzo furans
PCP	Pentachlorophenol
PEI	Polyethyleneimines
PGW	Pressurised ground wood pulping
RCF	Recycled fibre
Retention	The percentage of substances, both solids and solubles retained in the paper rather than passing to effluent
RMP	Refiner mechanical pulping
Save-all	The fibre recovery unit, filtration, flotation or settlement. Also produces clarified water
SECp	Specific Energy Consumption
SEPA	Scottish Environmental Protection Agency
SGW	Stone ground wood pulping
Size-press	The area of the machine where size is applied. Within the drying section of the machine
Stock	The suspension of fibres being prepared for the machine. Thick stock is 3-5% solids, thin stock generally less than 1% solids
SS	Suspended solids
STW	Sewage treatment works
TCF	Totally chlorine free (pulp bleached without any chlorine compounds)
TMP	Thermo-mechanical pulping
TOC	Total Organic Carbon
TRS	Total reduced sulphur
UF	Urea formaldehyde
VOC	Volatile organic compounds
Web	The continuous sheet of paper once formed on the wire
Wet-end	Wet end chemistry or plant is that associated with the stock as opposed to that at the coating or size press areas
Wire	On a paper machine, the continuous loop of porous mesh onto which the suspension of fibres is poured and on which the web is formed by drainage of the water through the wire
Wood-free	Paper made from pulp from which the lignin has been largely dissolved by chemical means

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. *Raw papermaking effluent (< 1000 mg/l COD)*
3. *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

4. *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.

5 *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.*

   Forestry use or raw material contamination

   NaOH or cadmium can be present naturally in timber.

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, 1^{st} Ed., Geneva, Switzerland, ISO 1993.

See also Monitoring Guidance Ref. 23

A1.4 Sampling strategies for solid materials.

Where there are problematic contamination issues, it is sometimes necessary to monitor waste paper or pulp for contaminants. It is possible to obtain a representative sample of something even as variable as waste paper. The appropriate strategy for solid materials depends upon its variability.

If the contaminants for which one is looking are liable to be reasonably constant, such as in a single batch of bought-in pulp, then few samples are needed; 4 grab samples taken randomly from each batch would normally suffice.

If it is highly variable such as waste paper then a regime such as:

- 10 grab samples daily (with visual assessment of samples which appear to be representative)
- repeated every day for a month, bulked together and sampled for contaminants, this gives an analysis based on more than 3600 samples per year, which will lead to statistically valid results.

Contaminants should be extracted by a process representative of the pulp and paper activity. Extracting contaminants by hot water, say at 80°C, is more appropriate than solvent extraction.

For sludge sampling for landspreading see Refs 17 and 18.

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

APPENDIX 3 - SUMMARY OF MAIN CHEMICALS USED

Table A.3.1 - Chemicals Used in Main Chemical Pulping Processes in the UK

Chemical	Purpose and process	Final form	Total doses used (% on wood)??
Sodium hydroxide	Acid neutraliser in NSSC *(Also cooking chemical in Kraft, soda and alkaline sulphite processes)*	Salt	8-15 Kraft
Sodium carbonate	Buffer/acid neutraliser in neutral sulphite process (e.g. NSSC)	Sodium carbonate or bicarbonate	1-2 NSSC
Sodium sulphite	Cooking chemical in neutral and alkaline sulphite process (no free SO_2)	Lignosulphonate	8-18 NSSC
9,10-anthraquinone	*Pulping aid mainly in Kraft* and soda processes	Not recoverable	0.5-1

Items in italics are not currently relevant in the UK.

Table A.3.2 - Summary of Chemicals Used in De-inking

Function	Materials	Principal environmental characteristics
Fibre swelling and ink detachment	Caustic soda	High pH
Suspending agent	Sodium silicate	High pH
Ink removal by flotation	Fatty acid soap	Biodegradable
Bleaching or Brightening	Sodium hydrosulphite Hydrogen peroxide/NaOH Oxygen/NaOH Sodium hypochlorite (only wood-frees)	Deoxygenation Chelants (DTPA) sometimes used High pH Chloroform, AOX production
pH adjustment	Sulphuric acid	Low pH
Clarifier flocculants	Various, e.g. polyacrylamides, polyamines, polydadmacs, PAC, etc.	Poor biodegradability Aquatic toxicity from cationics
Conditioning of De-inking sludges	Polyacrylamides	Poor biodegradability Aquatic toxicity from cationics

BREF Table 5.1 for more details and application rates.

Table A.3.3 - Chemicals Used in Main Chemical Pulp Bleaching Processes

Chemical	Manufacture	Function	Dose (kg/tonne pulp)	Used in UK
Chlorine	Off-site or on-site brine electrolysis	Dissolves residual lignin by oxidation and chlorination, thus generating chlorinated organics.	50-70	N
Sodium hydroxide	Co-produced with chlorine	Used with oxygen in pre-delignification stage, hydrolyses chlorolignins and dissolves lignins in extraction stages and is also used in TCF processes	25-50 overall	N
Chlorine dioxide	On-site from sodium chlorate	Dissolves lignin without chlorination and protects cellulose from degradation	20-50 as $NaClO_3$	N
Sodium hypochlorite	From chlorine and caustic soda	Brightens pulp in later stages, but generates chloroform and can attack cellulose	0-10	Y
Oxygen (and magnesium ions in pre-bleaching)	Off-site or on-site by PSA or cryogenic plant	Oxidises and dissolves lignin in pre-bleaching stage and reinforces caustic extraction stages	10-20 O_2 and 0-3 $MgSO_4$ in O stage 4-8 in EOP stage	N
Hydrogen peroxide	Off-site	Oxidises and brightens lignin in extraction stage or full peroxide stage	2-5 in EOP stage up to 40 in TCF	Y
Chelants e.g. EDTA, DTPA	Off-site	Used in full peroxide stage or in pre-treatment stage	2-4	Y
Peracetic acid	Off-site	Oxidises and dissolves lignin in first stage only		N
Ozone	On-site from air or more usually from oxygen	Oxidises and dissolves lignin, but may attack cellulose	5-10	N
Enzymes (xylanases)	Off-site	Facilitates later lignin removal by chemicals	-	N

Table A.3.4 - Chemicals Used in Mechanical Pulp Bleaching Processes

BREF Table 5.1

Function	Materials	Addition rate (kg/tonne)	Principal environmental characteristics
Bleaching or Brightening	Sodium hydrosulphite	4-10	Deoxygenation
	Hydrogen peroxide/ NaOH	10-25	Chelants (DTPA) sometimes used
	Oxygen/NaOH	0-10	High pH
	Sodium hypochlorite (only wood-frees)	0-10	Chloroform, AOX production
pH adjustment	Sulphuric acid	Variable	Low pH

Table A.3.5 - Summary of Fibre Used in the Main Paper Grades

Paper Grade	Fibre Composition	Product additives		Water use (m^3/t)
		Main	Optional	
Newsprint	90-100% mechanical pulp + 0-10% bleached chemical pulp or 100% de-inked pulp	None	Filler (<5%), dyes	10-20
Wood-containing printings	50-70% mechanical pulp (some de-inked pulp possible) + 30-50% bleached chemical pulp	Filler (20-40%), Starch	Dyes	15-30
Wood-free printings and writings	100% de-inked pulp to 100% bleached chemical pulp	Filler (10-30% uncoated), size, starch	Dyes, OBAs, wet strength	10-50
Linerboard (testliner)	100% recovered paper (non-de-inked) to 100% unbleached Kraft pulp	Size, starch	Dyes, wet strength	<10
Corrugating/ fluting medium	100% recovered paper (non-de-inked) to 100% NSSC pulp	Starch	-	<10
Other packagings (e.g. sacks, folding boxboard)	All pulp blends possible depending on grade	Size, starch	Filler, wet strength, fluorochemicals	5-30
Tissue and towel	100% de-inked pulp to 100% bleached chemical pulp with some CTMP possible	Dry strength aids Wet strength aids (not toilet tissue)	Dyes, OBAs, softeners, creping aids	20-100
Speciality	Mainly bleached chemical pulps, sometimes non-wood	Grade dependent	Grade dependent	50-200

Notes: Wood-containing means containing mechanical pulp, wood-free means containing no more than 10% mechanical pulp.

OBA = optical brightening agent

Table A.3.6 - Summary of Main Chemical Additives Used in Papermaking

Raw material/ function	Chemical nature/composition	Addition rates (dry solids basis)	Form of addition	Addition point	Retention characteristics	Principal environmental characteristics
Fibre	Cellulose, hemi-cellulose, lignin, extractives	50-100% of final paper weight	Dry bales or slurry from integrated pulp mill	W	High overall (>95%) dependent on fines content and degree of flocculation allowable	Deposition in watercourses from cellulose Oxygen demand from celluloses Coloration of watercourses from lignin Aquatic toxicity from extractives
Mineral fillers for opacity, surface smoothness, etc	Kaolin clay, calcium carbonate , talc, titanium dioxide	0-35% 0-5% 0-20%	Powder or slurry	W SP C	Moderate on wire (40-70%), but high overall (>90%) dependent on filler flocculation	Potential dust when dry Light-scattering and deposition in watercourses
Sizes for water resistance	Rosin with alum or PAC Alkyl ketene dimer (AKD) Alkenyl succinic anhydride (ASA) plus emulsifiers/promoters	0-20 kg/t paper	Aqueous Dispersion or emulsion	W W, SP W	High overall (> 90%), dependent on charge balance and degree of flocculation	Aquatic toxicity but biodegradable
Dry strength Additives	Natural and modified starches Polyacrylamides	0-20 kg/t paper 0-60 kg/t paper 0-5 kg/t paper	Aqueous solution	W, SP W	100% at size press, but loss on broke repulping, high for wet end cationics	Biodegradable Non-biodegradable
Wet strength Additives	Urea and melamine formaldehyde resins Polyamidoamine-epichlorhydrin resins	0-10 kg/t paper	Solution/ suspension Solution	W	High (>90%), but dependent on charge balance	Presence of some free formaldehyde (VOC) Presence of chlorinated organics, e.g. DCP Poor biodegradability
Dyes for Coloration	Various, e.g. azo-based dyes + auxiliaries (e.g. urea and cationic fixatives)	0-50 kg/t paper	Aqueous solution	W, SP, C	Variable at wet end 70-98%	Poor biodegradability Aquatic toxicity in few cases. Auxiliaries largely biodegradable or inorganic
Fluorescent brighteners	Diaminostilbenesulphonic acid derivatives	0-20 kg /t paper	Aqueous solution	W, SP, C	Variable at wet end	Poor biodegradability
Retention/drainage aids to reduce losses	Various, e.g. alum, polyacrylamides, polyethyleneimine, polyamines, silica, bentonite	0-2 kg/t paper	Aqueous solution/emulsion	W	High (>95%) overall retention	Aquatic toxicity from cationic polymers General poor biodegradability Sulphate (alum) as source of H_2S
Biocides to Control slime	Various from inorganics (e.g. ClO_2, peroxides) to organics (e.g. isothiazolones)	< 1 kg/t paper	Solution (organic solvents possible)	W	Deliberately not retained	Poor biodegradability and aquatic toxicity, but very substance specific
Additives for control of deposits, e.g. pitch	Various, e.g. alum and talc for pitch, organic detackifiers for stickies	< 1 kg/t paper	Powder (talc), solution (others)	W	Deliberately not retained	Aquatic toxicity from cationics
Defoamers	Various, e.g. hydrocarbons, silicones, ethoxylatees, fatty acid esters, etc	< 1 kg/t paper	Oil-based or water-based emulsion	W	Deliberately not retained	Slow biodegradability Affect oxygenation of waters
System cleaners	Various, e.g. caustic soda, surfactants	Batch dosing	Usually aqueous solution	W	Deliberately not retained	High pH Poor biodegradability

Notes: Dyes used are mainly water-soluble versions of azo, stilbene, di & tri phenylmethane, xanthene, acridine, quinoline, azolidene, oxazolidine, thiazolidine, anthraquinone, indigo and phthalocyanine dyes. There is little use of reactive dyes.

W, SP, C wet end, respectively