IMPLEMENTATION OF BAT AND THE IPPC DIRECTIVE IN LITHUANIAN FOOD, DRINK AND MILK INDUSTRY

Guidance Notes for Operators and Regulators

Final Report

MTT Agrifood Research Finland

Rabbe Thun & Yrjö Virtanen

January 2007

FOREWORDS

This report has been prepared within the scope of a project on Best Available Techniques (BAT) and the implementation of the IPPC Directive (Integrated Pollution Prevention and Control) in Lithuanian food, drink and milk industry (FDM). The overall purpose of the project, which is finacially supported by the Finnish Ministry of the Environment, is to provide assistance with capacity building within the framework of IPPC and BAT to the Environmental Protection Agency (EPA) of Lithuania and to its 8 Regional Environmental Protection Departments (REPD´s).

The more specific project objectives are the following:

- ⇒ To assist and guide the Lithuanian authorities with the preparation of Guidance Notes on IPPC implementation and BAT application within Lithuanian food, drink and milk industry.
- ⇒ To provide and organise information and experience exchange between Finnish and Lithuanian experts on IPPC and BAT within the FDM sector.
- ⇒ To assist the Lithuanian authorities with the preparation of IPPC Application Forms (Templates) and related Explanatory Notes, and to assist a few selected companies with the preparation of draft IPPC Permit Applications. These applications will be used as reference documents in further work with companies from the Lithuanian FDM sector.
- ⇒ To disseminate information on project results (introduction of the application template, annotations, explanatory notes, findings from training program and drafting of permits) to the staff of MoE, REPD, State Environmental Protection Inspectorate and EPA, as well as to representatives of the industry concerned.

The Finnish Environment Institute in collaboration with the Lithuanian Environmental Protection Agency is responsible for the execution of the project. Other Finnish organisations involved in the project are MTT Agrifood Research, Finland; The Southwest Finland Regional Environment Centre and Valio Ltd.

There are presently about 160 companies covered by the IPPC Directive framework in Lithuania. They will need IPPC permits before 2007. Implementation of the IPPC Permit system requires assessment of compliance of the technologies presently used by the companies compared to those described in the EU's BAT Reference documents (so-called BREFs). All questions related to IPPC permitting and application, and to the application of BAT, in particular guidance notes for the individual branches of industry in Lithuania, should be prepared and operational by 2007.

The food, drink and milk industry has been chosen as the target area, as it is relatively small and thus realtively easy to handle in a project of this size. It is also an important sector for Lithuania, both in terms of export and employment, and recent Finnish experience on IPPC Permits, as well as on BAT implementation is available. The number of currently affected FDM companies in Lithuania is 13. They are situated in all eight Regional Environmental Protection Departments, which are responsible for issuance of the IPPC Permits and for providing guidance to the companies concerned.

This report is meant to serve only as a background document and includes information on the structure, content and role of Guidance and/or Explanatory Notes, information on the application and issuance of IPPC Permits, and includes some examples of BAT assessment within IPPC Permits granted to Finnish FDM plants. As no sector-specific nor horizontal Technical Guidance Notes have been prepared or issued by the Finnish environmental authorities and the Explanatory

Notes issued are quite general to their nature, much of the information given in this report has been taken from guidance documents issued by the EPA in the UK.

The report has been compiled by senior researcher, Mr Rabbe Thun from MTT Agrifood Research Finland. Mr Yrjö Virtanen, who is MTT's official contact person in the project has acted as a supervisor and has also provided valuable comments on the contents of the report.

FOREWORDS 3

1. IPPC Permits and BAT Requirements 8

2. Implementation of the IPPC Directive in Finland 10
2.1. Application and Issuance of a Permit 10
2.2. BAT Assessment 11
2.3. Emission Limits, Monitoring and Control 13

3. The Objective and Purpose of Guidance and Explanatory Notes 15

4. Guidance on Permit Applications 19
4.1. Application Forms and Requested Information 19
4.2. Administrative Guidance 21
4.3. Guidance for New Permit Applications 23
4.4. Guidance on the Completion of a Site Report 25

5. Structure of Guidance Notes on BAT for the FDM Sector 28

6. Technical Guidance for Water Use and Wastewater Reduction 31

7. Technical Guidance for Wastewater Treatment in the FDM Sector 34
7.1. General Principles 34
7.2. Preliminary techniques 35
7.3. Flow balancing and equalisation 35
7.4. Diversion tanks 36
7.5. Primary treatment 36
7.6. Biological treatment 38
7.7. Secondary treatment 38
7.8. Tertiary treatment 39
7.9. Sludge treatment and disposal 40
7.10. Sludge treatment techniques 40

8. Technical Guidance on the Application of BAT in Dairies 43
8.1. General Features of Dairy Industry 43
8.2. BAT Issues to be covered 45
8.3. Guidance on In-Process Controls 46

9. Horizontal Guidance on Industrial Cooling Systems 48
9.1. General Aspects and Principles 48
9.2. Cooling Systems 49
9.3. Environmental aspects 51
9.4. BAT assessment 54

10. Indicative BAT Requirements for Management Techniques 58
- 10.1. Operations and Maintenance 58
- 10.2. Competence and Training 58
- 10.3. Accidents, Incidents, and Non-Conformance 58
- 10.4. Organisation 59

11. Horizontal Guidance on Waste Minimisation 60

12. Guidance on Energy Efficiency 62
- 12.1. Purpose of the Guidance 62
- 12.2. Information on Energy Consumption 63
- 12.3. Energy Efficiency Plans 65

13. Guidance on Control and Monitoring of Emissions to Air 67
- 13.1. Emission of Particulates and Gaseous Species 67
- 13.2. Horizontal Guidance for Odour Control 68

14. Horizontal Guidance for Noise 72
- 14.1. Purpose and Scope 72
- 14.2. Calculating Noise Levels 72
- 14.3. Assessment of Noise Impact 72
- 14.4. Noise Survey Methodology 73
- 14.5. Noise Control - General Principles 74
- 14.6. Management of Noise 74
- 14.7. Noise Control Practices 76
- 14.8. Noise-Control Equipment and Techniques 77

15. Horizontal Guidance for Cross-Media Effects and Cost-Assessment 79
- 15.1. Cross-Media Effects 79
- 15.2. The Costing Methodology 82
- 15.3. Evaluating the Alternatives 84

16. Horizontal Guidance for Risk Assessment 85
- 16.1. The OPRA Methodology 85
- 16.2. Complexity Attribute. 85
- 16.3. Location Attribute. 86
- 16.4. Emissions Attribute. 86
- 16.5. Operator Performance (Management Systems) Attribute 86
- 16.6. Compliance Rating Attribute. 87
- 16.7. Determination and review of EP OPRA banded profiles 87
- 16.8. Use of OPRA in Compliance Planning 88

17. Benchmarks and Limits in Permits 89
- 17.1. Units for Benchmarks and the Setting of Limits in Permits 89
- 17.2. Statistical Basis for Benchmarks and Limits in Permits 90

18. Finnish Experiences of BAT Assessment and IPPC Permits 91
18.1. A Food Processing Plant 91
18.2. A Vegetable and Berry Processing Plant 93
18.3. A Fruit Juice Processing Plant 94
18.4. A Milk Processing Plant 96
18.5. A Brewery 98

19. References 101

20. Appendices 104

1. IPPC PERMITS AND BAT REQUIREMENTS

The system of Integrated Pollution Prevention and Control (IPPC) applies an integrated environmental approach to the regulation of certain industrial activities. This means that emissions to air, water (including discharges to the sewer) and land, plus a range of other environmental effects, must be considered together. It also means that regulators must set permit conditions so as to achieve a high level of protection for the environment as a whole. These conditions are based on the use of the '**Best Available Techniques' (BAT**), which balances the costs to the operator against the benefits to the environment. IPPC aims to prevent emissions and waste production and where that is not practicable, to reduce them to acceptable levels. IPPC also takes the integrated approach beyond the initial task of permitting, through operation to the restoration of sites when industrial activities cease.

The legal instrument that ultimately defines BAT is the **Permit**, and this can only be issued at the installation level. According to Article 9 of the IPPC Directive the technical characteristics, geographical location, and the local environmental conditions of a certain installation or plant should be taken into account when setting **Emission Limit Values**, when specifying technical measures or requirements based on BAT, and when setting **Conditions** for the issuance of permits.

When assessing the applicability of sector-specific indicative BAT standards at installation level, departures may be justified in either direction. Selection of the technique, which is most appropriate, may depend on local factors and, where the answer is not self-evident, an installation-specific assessment of the **Costs and Benefits** of the available technological options is needed.

All environmental impacts of activities must be examined in a fully integrated way. Discharges and emissions released into the air, water or the soil must all be assessed simultaneously, together with other factors such as resource consumption, waste minimisation, energy efficiency, noise and vibration, and accident prevention. Operators need to prove that their installations function in ways that prevent discharges and emissions, wherever this is practically possible, or that they reduce emissions to acceptable levels by using BAT. Sites must also ultimately be returned to a satisfactory state after operations cease.

In the assessment of BAT at the installation level, the cost of improvements and the timing or phasing of that expenditure, are always factors to be taken into account. However, they should only be major or decisive factors in decisions about adopting indicative BAT, where: /6/

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

In summary, departures by an individual installation from indicative BAT for its sector 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 the basis of individual company profitability, nor if significant pollution would be the result of departures from BAT requirements.

The Regulators should encourage the development and introduction of innovative techniques that advance indicative BAT standards criteria, i.e. techniques:

- ✓ that have been developed on a reasonably large scale,
- ✓ that reasonably allows implementation in the relevant sector,
- ✓ that are technically and economically viable, and
- ✓ that further reduce emissions and their impact on the environment as a whole.

One of the main aims of the PPC legislation is **continuous improvement** in the overall environmental performance of installations, as a part of progressive sustainable development.

For an existing installation, it may not be reasonable to expect compliance with indicative BAT standards immediately, if the cost of doing so is disproportionate to the environmental benefit to be achieved. In such circumstances, operating techniques that are not at the relevant indicative BAT standard may be acceptable, provided that they represent what is considered BAT for that installation and otherwise comply with the requirements of the Regulations. The determination of BAT for the installation will involve assessment of the technical characteristics of the installation and local environmental considerations, but where there is a significant difference between relevant indicative BAT and BAT for an installation, the Permit may require further improvements on a reasonably short timescale.

Where there are departures from relevant indicative BAT standards, Operators of existing installations will be expected to have **Upgrading Plans and Timetables**. Formal timescales for upgrading will be set as **Improvement Conditions** in the Permits.

2. IMPLEMENTATION OF THE IPPC DIRECTIVE IN FINLAND

2.1. Application and Issuance of a Permit

To fulfill the requirements of the IPPC Directive in Finland, changes in legislation had to be made. A new national Environmental Protection Act and Decree came into force on the 1st of March 2000. According to this law an Environmental Permit is required for all activities that may lead to pollution of the air or water, or to the contamination of the soil. Presently there are about 700 IPPC installations in Finland, of which 40-50 belong to food industry. All these plants had to submit an Application before the end of year 2004.

The contents of an Application are defined in the Environmental Protection Act and Decree. The Application consists of a classification of the needed Permit, an identification of the applicant, a description of the activity, an environmental impact assessment of the activity, a plan for monitoring of emissions, a plan for waste management etc., and the reporting of monitoring data, a risk assessment, and a BAT assessment /27/.

Companies that are applying for an Environmental Permit for an industrial installation in Finland are requested to complete the application form (see Appendix 2) and to follow the instructions or guidance notes that can be downloaded from the net-site: www.ymparisto.fi/luvat. At least three copies of the application should be sent to the local responsible environmental authority in the area of operation.

It is not mandatory to very strictly follow the form and all related guidance notes, but the applicant is adviced to present the requested information in the same order that is used in the general template. Separate forms or templates are available for the following industrial sectors:

- ✓ boiler plants;
- ✓ fish breeding farms;
- ✓ animal farms;
- ✓ asphalt production and stone crushing plants.

It is recommended that the applicants are in contact with the responsible authorities already before the Application is being prepared and/or sent in, and in good time before the plant is due to start its operation. The Application should include a clear and concise description of the operational performace, its impacts, responsible persons, and information on any other issue of relevance for the issuance of a permit. If requested or seen necessary, information on sources of data and on methods used for the assessment of impacts should be revealed. The person responsible for the completion of the Application should be reasonably well aware of the environmental legislation, techniques, environmental impacts, etc. If the applicant regards some of the information given as confidential, it should be marked as such. Data on emissions, monitoring and control can, however, not be classified as confidential information /27/.

If the activity for which the Permit is sought falls under the law of environmental impact assessment (EIA) a separate EIA-document should be attached.

If the operation of the plant is changed significantly or so that it has a significant effect on emissions and impacts a new Permit must be sought, according to what is stated in the

Environmental Law. An application to review the Permit conditions shall normally be made in about ten years, even if no changes in the activity have been made /2/.

The issuance of a permit is a two-stage procedure /1/. The first stage includes the following steps:

- ✓ Checking of the Application;
- ✓ Completion of the Application if seen necessary (i.e. some information missing);
- ✓ Negotiations and inspections;
- ✓ Announcement of the Application in local newspapers and on a public notice board;
- ✓ Additional information is available from the responsible permitting authority for 30 days;
- ✓ Special announcement to all concerned parties (case by case consideration, but at least all neighbouring estates)

The second stage includes the following steps /1/:

- ✓ Statements are asked from the following authorities:
  - all municipalities in the impact area;
  - all supervision authorities;
  - other isntitutions (case by case consideration)
- ✓ Complaints and/or opinions gan be given by:
  - all parties affected by the Application;
  - NGOs and other registered associations

The applicants can always give a reply to statements, complaints, and opinions forwarded.

2.2. BAT Assessment

When applying for a Permit an assessment of, how production techniques and processes, raw materials' usage, schemes for reduction of emissions and wastes, and procedures for efficient energy use correspond to BAT, should be carried out. The environmental impacts of the operation should be assessed from a holistic perspective and through an integrated approach, that is, emissions to the soil, air and water, as well as waste issues and energy efficiency should be assessed simultaneously. The technical and economic possibilities of BAT implementation should furthermore be addressed. This is especially important for big plants and combined production units, whose operation affects several and different environmental media.

When assessing BAT the following issues should be dealt with /27/:

- ✓ Reduction of the quantity and hazardousness of wastes;
- ✓ The use of hazardous materials and the possibility of using less hazardous ones;
- ✓ The possibility of recycling and reusing materials and wastes from production processes;
- ✓ The quantity, quality and impacts of emissions;
- ✓ The quality and wear of raw materials;
- ✓ The energy-efficiency;
- ✓ Prevention of risks and accidents at source, and prevention of causes of accidents;
- ✓ Time scale for implementationa of BAT, the relevance of its planned starting date and costs, benefits of the prevention, and emission reduction schemes;

- ✓ All environmental impacts;
- ✓ Methods and procedures of production and emission control at an industrial scale;
- ✓ Progress in technology and scientific know-how;
- ✓ Published information and data on BAT by the European Commission or International Organisations.

Mutual cross-media effects (trade-offs) of the operation should furthermore be assessed. As an example of cross-media effects, the reduction of air emissions by electrostatic precipitators can be mentioned. On the one hand the Operator should assess, how the use of the precipitators affects air emissions and on the other hand the Operator should assess, which are the simultaneous effects on the amount of wastes and on the energy use. Other alternatives for air emissions may be available and also these should be assessed from the perspective of total environmental loads. A similar example can be given from the field of wastewater treatment. On the one hand the Operator should assess, how more efficient wastewater treatment will affect the run-off water, on the other hand, what kind of effects will it have on the use of chemicals and energy.

If the Operator has several alternatives for emission reduction, all available techniques and their respective cross-media effects should be assessed. Alternative BAT techniques and procedures, and combinations of these or other measures of improvement, by which the total environmental loads can be reduced most efficiently, should be assessed.

According to the Finnish Environmental Law "Best Environmental Practices", BEPs mean the most practical and cost-efficient ways of pollution prevention. These can be working methods, operational procedures, and the selection of raw materials or fuel. In many countries the term "Best" has been changed to "Good", as the setting of transparent criteria for what is best, is a very challenging and a more or less impossible task. BAT is considered when permit conditions for emissions and when technical requirements are set. For BAT evaluation BREFs, Helcom recommendations, Nordic and national reports, and reports of industrial branch organisations are used. Practical experience from other enterprises and co-operation with industries and regional environmental centres are also essential /1/.

In Finland, the Finnish Environment Institute (SYKE) is responsible for issues related to BAT. SYKE acts as the National Focal Point in the exchange of BAT information between the EU member states and industry, as organised by the European Commission. SYKE co-ordinates contributions from Finland including draft BAT reference documents (BREFs), and publishes general information on BATs through the National BAT Steering Group, which consist of representatives from the Ministry of the Environment, the Ministry of Trade and Industry, the National Technology Agency (TEKES), regional environmental centres (the permit and enforcement authorities), the Confederation of Finnish Industry and Employers, and the Finnish Association for Nature Conservation.

The actual preparation of sector-specific BREFs is carried out by National Technical Working Groups, with one group representing each of the 33 BREF work programme categories. These Working Groups are composed of representatives from industry and the permit authorities, with the group's chairperson always acting as the Finnish member in the corresponding EU system of Technical Working Groups (TWGs). The Working Groups comment on draft BREFs prepared by the European IPPC Bureau (EIPPCB) and on other documents, and organise the preparation of Finnish BAT reports.

The National Technical Working Group Forum has allowed all parties to gain a deeper common understanding of how BAT principles can be applied, and there is clearly a need for these groups to continue working even after all the currently planned BREF documents are completed.

BAT work and national BREF working groups have been used for strengthening the co-operation between authorities and industry even on a broader basis than just for BAT purposes. About half of the working group members represent authorities and half of them are from industry and/or represent branch organisations.

2.3. Emission Limits, Monitoring and Control

The Permit is valid only for activities defined in the Application. If major changes are made the Permit must be reviewed. **Limit values** for emissions to air and water, noise limits and **conditions** for waste management are set. Conditions for monitoring are also defined, as for example for the assessment of energy efficiency.

If the plant is connected to a municipal wastewater treatment plant, no limits are usually set in the Permit, but an agreement with the municipality is compulsory. However, if a Helcom recommendation or an EU Directive requires so, or the treatment plant is small compared with the industry's load, limit values are set (e.g. metal limits for surface treatment plants). If possible, the same level of effluent quality is used for industries as for the municipal treatments plants (BOD_7 ca 10 mg/l, total-P ca. 0,5 mg/l, total-N 50 – 70 % reduction depending on location) /1/. For food industry plants the Helcom Recommendation 17/10 is followed. IPPC plants normally achieve these values, but smaller plants often have difficulties in achieving the limit values.

For small boiler plants the limit value for dust emissions has been set at 40 mg/MJ. Maximum noise level at nearest neighbors is set at 55 dB in daytime and at 50 dB durig night hours. No disturbing smell is generally allowed and the formation of waste should be reduced to a minimum. Generation of waste is accepted only for an operator that has a permit for disposal of such waste.

The national legislation also sets some overall requirements for monitoring and control. In general all activities that need an environmental permit are obliged to do maintenance monitoring and to register the amounts of raw materials, products, fuels, waste, water consumption etc.

The operator should present a **Monitoring Plan** in the Permit Application. The Monitoring Plan is reviewed by the authority and is accepted as a part of the Permit or in a separate acceptance process. The authority does a periodical checking of the monitoring results, but the regional authority does very little monitoring (water emissions, noise). Measurements, tests and investigations must be done in a qualified, reliable and appropriate way.

Monitoring of the permit conditions is made at the cost of the Operator, in most cases using a consulting organisation for analyses, sampling etc. Only the biggest enterprises monitor most of their emissions themselves, e.g. wastewater emissions and the functioning of the treatment plant are surveilled with daily samples that are analysed in the company's own laboratory. Air emissions are monitored at big plants with continuous instruments for most usual parameters. Other measurements are usually carried out by competent bodies /2/.

Wastewater sampling is, however, due to practical reasons usually done by the plant. Samples are normally collected with automatic samplers for at least one working day to avoid occasional errors caused by variations in water quality. When the analyses are done in the company's own laboratory, the methods must be approved and control measurements at the Finnish environment institute's laboratory must be done.

Monitoring of the water quality in the receiving water system must always be done by a competent body, which is under public surveillance. Smaller enterprises usually rely on a consultant laboratory, which fetches the samples and also gives practical advice on maintenance of the wastewater treatment system.

Annual reporting is a core of the environmental surveillance. Presently the request for reporting covers ~700 organisations. Numeric data is sent by e-mail or normal mail to the regional environmental centres that maintain a database. Other information, such as third-party monitoring and analysis reports, risk analyses etc. is also collected.

The use of two separate surveillance bodies (the Regional Environmental Centres and the municipalities) is considered to be a bit confusing and routine inspections are affected by the lack of enough surveillance personnel. Unclear permit conditions often lead to different interpretations by all parties and the database does not provide optimal support for supervisors. Verification and validation by third-party measurements are thus crucial /2/.

3. THE OBJECTIVE AND PURPOSE OF GUIDANCE AND EXPLANATORY NOTES

To gain a Permit, Operators will have to show that they have systematically developed proposals and plans on how to apply Best Available Techniques (BAT) and how to meet certain other requirements, taking account of relevant local factors. To assist Operators in making applications, separate, **Horizontal Guidance** should be available on a range of topics such as wastewater treatment, waste minimisation, energy efficiency, emission monitoring, calculating stack heights, risk assessment, and so on. More detailed **Vertical Guidance** should also be available on sector-specific technical issues.

Explanatory Notes on how to use these horizontal and vertical guidance documents, explanatory notes on how to complete the application forms, and **administrative guidance** on how the application will be handled by authorities, should also be provided by the Regulator.

The Guidance and/or Explanatory Notes should provide Operators and the Regulators with advice on indicative standards of operation and on environmental performance relevant to the industrial sector concerned. They should assist the former in the preparation of applications for IPPC Permits and the latter in the assessment of those Applications, and in the setting of a subsequent compliance regime.

The use of techniques quoted in the **BAT Guidance Documents** and the setting of emission limit values (ELV) at the benchmark values quoted in the **ELV Guidance Documents** should not be mandatory, except where there are statutory requirements from other legislation. However, the Regulators should carefully consider the relevance and relative importance of the information in the Guidance Documents to the installation concerned, when making technical judgments about the installation, and when setting Conditions in the Permit. Any departures from indicative standards should be justified on a site-specific basis /*6*/.

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

The Regulator may for example provide the Operator with explanatory notes on the following issues /5,6,33/:

- ✓ What is IPPC and where can I find information on BAT?
- ✓ Putting environmental assessment in its right context;
- ✓ The content and purpose of technical description of installations and operation;
- ✓ The meaning of indicative requirements;
- ✓ Justification of deviations from indicative requirements;
- ✓ Comparison of proposed emission reduction techniques with BAT benchmarks;
- ✓ The purpose of the environmental impact assessment;
- ✓ Specified waste management activities;
- ✓ Information with relation to proposed changes of operation;
- ✓ Assessment of the effects of changes on the environment;

- ✓ Information on parts of a site that will be surrendered.

Examples of two explanatory notes, provided by the EPA in Scotland in their guidance document on Permit Applications /33/, are given below. A few more examples are listed in Appendix 1.

<u>Example of an Explanatory Note for the Technical Description of a Plant /33/</u>

”You need to provide us with a technical description of your plant including how it compares with the indicative BAT in the guidance, which, where appropriate, has been included in the template questions. Section 2 is laid out to show you the primary information we need, and the level of detail required”.

”Please bear the following in mind when justifying your performance against the indicative BAT techniques”:

- ✓ *”Each indicative BAT option is not compulsory in its own right. They are listed so that the operator can select the options applicable to the installation in question in order to demonstrate that all appropriate pollution preventative measures are taken.”*
- ✓ *”Even for a well-performing installation the answer may be ”No” for a number of questions. The reason for this may be that:*
  - *a technique not specified in the BAT guidance is being applied, which nonetheless has a similar, if not better environmental performance;*
  - *the technique is not applied as its impact is marginal when compared to another technique or combination of techniques;*
  - *although not applied at the time of application, its implementation has been included in the improvement programme.”*
- ✓ *”Plants vary considerably (particularly in the food, drink and milk sector) and these tables and questions will not answer every situation or allow you to demonstrate the performance of your installation in the way you would prefer.”*
- ✓ *””Comment/further information” boxes are provided in most sections to allow you to express different approaches or to put your answers into context.”*

”People vary in their preferences for the order in which they tackle issues; e.g. should ”management”, or ”materials input” or the ”main activities” be dealt with first? In this document they have been placed in the order of ”main activities”,”management”, and then ”materials input”. Please do not be thrown by this, but bear with it for the sake of consistency.”

”In some cases you may already have documentation on site which covers some of the issues. In most (but not all) cases we will be content with your confirmation that this existing documentation covers all of the issues we raise, and the supply of a ”document reference”, so that we can audit on site, is all that we require at this stage.”

”How much detail you put into the ”technical description” is for you to decide, and will depend on the complexity of the plant. Please keep in mind at all times that we want you to focus on the key environmental issues and improvements that need to be made, and to demonstrate that there is a high level of protection of the local and global environment. Providing superfluous information is generally a waste of your time and ours.”

”Your ”technical description” document can be the main part of your submission, with cross-references - or the majority of the information can be put into answer spaces. We will ask you in the BAT assessment on page xx to bring this information together to a conclusion.”

<u>Example of an Explanatory Note on Indicative Requirements /33/</u>

”Your submissions in response to such clear, indicative requirements should be as follows:”

- ✓ *”If you propose to comply with any clear, indicative requirement, you may need to describe how you will do this, if this is not obvious from the wording of the requirement itself. For example, if the clear, indicative requirement involves compliance with a specified emission limit value, you should explain what techniques you will use to achieve this. The guidance itself may indicate where such explanations are required.”*
- ✓ *”If you propose to deviate from any clear, indicative requirements, you should provide an explanation for this. Such deviations may involve proposals that are either stricter or less strict than the indicative requirements.”*

”Stricter proposals may be appropriate if you are seeking to apply new techniques that have become available after the publication of the guidance, or because the particular technical configuration of ‘standard’ techniques at your installation makes higher standards practicable.”

”Stricter proposals may also be necessary where, for example, the indicative standards would not secure compliance with an environmental quality standard in a particular area. You are advised to consider such possibilities at this stage, and develop further proposals as necessary, rather than assuming that compliance with indicative standards will always be sufficient to obtain a permit. If you do not do this, and your assessment of the environmental effects of your proposals or other information suggests that your releases will have unacceptable impacts, we will not permit you to operate at the standards you propose.”

”Less strict proposals may be justified due to particular factors relating to your installation or the local environment. For example, you may operate 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. If you wish to propose a deviation on such grounds, however, it is essential that you provide a properly costed justification, setting out how the costs of techniques compare with the emission reductions achievable. You should not seek to justify less strict proposals simply on the grounds that you cannot afford to comply with the indicative standards.”

”Within the steps outlined above, there are various possibilities for the assessment and justification of proposals on a site-specific basis. These include:”

- ✓ *”Justification of deviations from indicative requirements in guidance;”*
- ✓ *”Assessment of options to determine which of those identified by guidance is best for a particular site; and”*
- ✓ *”Development of proposals for parts (or possibly all) of an installation that are not covered by guidance.”*

”The basic rule in such cases is that you should compare a range of options on the basis of costs and benefits, and propose what you think is most appropriate to meet the requirements of the PPC Regulations. However, the level of detail required will depend on the environmental significance of the matter in question.”

”In the more complex cases, which include any cases of departures from indicative standards or issues not covered by guidance where:”

- ✓ *”there are a range of options available which would lead to significantly different environmental effects, or”*

- ✓ *”the cost implications are a major factor (this tends to be connected with the control of the most significant emissions);”*

”It will be necessary to develop proposals through a detailed analysis of the costs and benefits of options. In such cases the assessment will need to compare the range of options against the BAT criteria set out in the PPC Regulations, taking into account the technical characteristics of the installation concerned, its geographical location and local environmental conditions.”

”From such an assessment it should be demonstrated that the proposed combination of primary process and abatement equipment satisfies the PPC Regulations.”

”In many situations, however, it will not be necessary to carry out a detailed analysis of options. This may be the case where, for example, an indicative standard is inappropriate for obvious technical reasons, such that a departure can be justified in just a few words. Equally, if there are only minor additional emissions from your installation beyond those covered by guidance, we would not normally require you to demonstrate that you have completed a detailed comparison of alternative control techniques. Rather, we would simply expect you to propose techniques that you believe will meet the requirements of the legislation. We will then consider if what you have proposed is acceptable.”

4. GUIDANCE ON PERMIT APPLICATIONS

4.1. Application Forms and Requested Information

In practice, some Applicants may submit far more information than is needed, yet without addressing the areas that are most important - and this will lead to extensive requests for further information. In an attempt to focus the applications to the areas of concern to the Regulator, Application Forms (Templates) and Explanatory Notes on how to complete these forms, should be produced by the Permit Issuing Authority.

In order to facilitate the application procedure e.g. the Environment Protection Agency in the UK has produced compact discs (CDs), which contain all relevant application forms, explanatory notes, technical and administrative guidance, BREFs and assessment tools, hyperlinked together for ease of use. The operators in most industrial sectors in England, Scotland and Wales have been provided with these CDs and the CDs can be ordered free of charge from the EPA (*www.environment-agency.gov.uk)*. This is, however, not the situation in all EU countries.

In Finland, for example, application forms can be downloaded from the Net (*www.ymparisto.fi*), and a separate document with explanatory notes /27/ have been issued, but, no separate technical guidance documents have been issued by the responsible regulatory body. References to sector-specific BAT documents and other reports addressing horizontal technical issues, such as i.e. energy efficiency are, however, given, and advice on how to complete the forms and/or on what kind of information should be provided, can also be sought from local environmental authorities (regional centers and/or municipalities) directly.

Technical questions that should be asked and addressed in the Application Forms or Templates are i.e. the following /5/:

- *“Does the installation produce less that 20m^3/d of aqueous effluent?”*
- *“Are there any emissions at all to controlled water or sewer?”*
- *“Do you believe that the operations give no reasonable cause for offence or annoyance from odour, and that the local authority officers and the regulator would agree?”*
- *“Are you applying to operate any specified waste management activities?”*
- *“What do you produce and how much of it?”*

More specific technical issues that should be addressed for i.e. a brewery should among others be the following /5/:

- *“Do you collect weak worts?”*
- *“Do you use dry methods to recover spent grains?”*
- *“Are filters used in the floor drains of the mash tun/lauter tun areas to reduce the amount of grains entering the effluent system?”*
- *“Is recovery of heat from the vapours of the wort kettles carried out?”*
- *“Is the trub returned to the mash kettle or lauter tun/mash filter?”*
- *“Are measures in place to prevent the overfilling of fermenters causing beer to be lost with the foam?”*

- *"Is surplus yeast and spent yeast slurry (including first washings from the relevant areas) collected, rather than washed to the drain?"*
- *"What is your benchmark figure for the collection of surplus yeast and spent yeast slurry?"*
- *"Do you use a bottle washer?"*

Some of these technical questions may require some explanation, which can be given as a separate note. The following explanatory note can e.g. be given to the issue of kieselguhr consumption in brewing of beer: /5/

"Consideration should be given to factors in order to promote yeast settling and thereby reduce kieselguhr consumption. The factors are":

- ✓ *the installation of a centrifuge,*
- ✓ *selection of malt,*
- ✓ *optimum brewhouse procedures,*
- ✓ *use of flocculent yeast strains,*
- ✓ *well designed storage and transfer equipment, and*
- ✓ *long storage periods.*

Another example is the one given to the question whether a bottle washer is used:/5/

"To minimise the water consumption of the bottle washer, you should ensure that":

- ✓ *There is an automatic valve to interrupt the water supply when there is a line stop.*
- ✓ *The most effective rinsing nozzles are used to reduce water use.*
- ✓ *There is control of the rinsing water flow (often the flow is much higher than specified or may vary due to pressure fluctuations in the water supply system).*
- ✓ *Rinsing water from the last two rows of rinsing nozzles should be collected and used for the other rinsing nozzles.*

The Operator should include in the Application a proposed plan or programme, in which all identified improvements (and rectification of clear deficiencies) are undertaken at the earliest practicable timetable. The Regulator will assess BAT for the installation and the improvements that need to be made, compare them with the Operator's proposals, and then set appropriate Improvement Conditions in the Permit.

All improvements should be carried out at the earliest opportunity and according to a programme approved by the Regulator, any longer time-scales, should be justified by the Operator. It is intended that all of the requirements identified in the BAT sections, both the explicit ones and the less explicit ones in the descriptive sections, should be considered and addressed by the Operator in the Application. Where particular indicative standards are not relevant to the installation in question, a brief explanation should be given and alternative proposals provided. Where the required information is not available, the reason should be discussed with the Regulator before the Application is finalised. Where information is missing from the Application, the Regulator may, by formal notice, require its provision before the Application is handled /6/.

4.2. Administrative Guidance

For completion of the Application Form, the following general advice in the form of a guidance note is given by the EPA in the UK /21/:

- ✓ *"Be concise, it is the quality of the application that counts not the size of it."*
- ✓ *"Set out clearly your response to each issue and explain whether your proposals depart from any relevant standards or benchmarks within the guidance. If your proposals are clearly set out and robustly justified, it makes consideration of the issues more effective and less time consuming for all parties."*
- ✓ *"It is essential that your application contains:"*
  - *A non-technical summary including a succinct summary of how you intend to operate your installation and why such operation represents BAT. A succinct non-technical summary should also assist other audiences such as statutory consultees and the public to understand and comment upon your application.*
  - *A reasoned justification that the techniques employed represent BAT. It is only sufficient to simply state that your chosen option represents BAT, if it corresponds with that specified as indicative BAT in the technical guidance and justification is not required for any other reason (e.g. local impacts).*
  - *Details of the emissions that will result from your proposed activities and their comparison with the relevant sector benchmark levels.*
  - *An assessment of the environmental and health impacts of the installation that demonstrates that a high level of protection for the environment and human health is provided.*
- ✓ *"For existing processes it may be advisable to do the impact assessment early on in the application process, as this should provide the order of priority for addressing the techniques employed."*
- ✓ *"You should include proposals and timescales for all aspects of the installation that require improving. Improvements should be completed as soon as possible and in most cases within 3 years."*
- ✓ *"Do not provide unnecessary information in response to any section of the application. For example in the management techniques section, we would not expect to see copies of working procedures included as part of the application. If you have a documented system which fully answers a particular point you should simply give the document reference and identify the post responsible for its maintenance. If you are not in a position to do this, you should provide a clear description of the management system in place and how it works to ensure that all appropriate pollution prevention and control techniques are consistently delivered and how compliance with regulatory requirements are maintained. To avoid duplication you do not need to reiterate any information provided in response to other application sections, simply state that this is provided elsewhere and cross-reference it clearly. As a guide we expect that you should be able to appropriately address this section of your application in approximately 6 pages."*
- ✓ *"Your application should refer to normal operations as well as abnormal and potential accident situations."*

- ✓ *"If in doubt about the content of your application, please discuss your queries with your local Area Office."*
- ✓ *"A good initial application means the Agency is likely to need to ask fewer questions later on, giving you a faster decision."*

Guidance or Explanatory Notes on e.g. the following Permit and Application issues should also be provided by the Regulator /6/:

- ✓ When do you need to apply for a new Permit?
  - When do you need to apply for a permit for a new installation?
  - When do you need to apply for a permit for an existing installation?
- ✓ What happens after a Permit has been issued?
  - Compliance
  - Permit reviews
  - Changes and variations
  - Permit transfers
  - Closure and site restoration (Decommissioning)
  - Public information
- ✓ How do you make an Application?
- ✓ How many copies are required?
- ✓ Applications for a variation to the permitted activity.
- ✓ Applications for the transfer of the Permit between operators.
- ✓ Applications for the surrender of permitted activities.
- ✓ What will the Regulator do with your Application?
  - Checking whether the application is duly made
  - Acknowledging receipt
  - Further information
  - Public register
  - Consultation
  - Determination
- ✓ How long should it take for a decision to be reached?
- ✓ What can you do if you are not satisfied with the outcome of your Application?
- ✓ Fees and charges
- ✓ Commercial confidentiality and national security
- ✓ Data protection notice
- ✓ Completion of the Application Form
  - About your application
  - Authorised contacts
  - About the operator
    - Legal status of operator.
    - Details for individual applicants.
    - Details for applicants' inpartnerships.
    - Details of the partnership.
    - Details of companies or corporate applicants.
    - Details of holding companies.
- ✓ Non-technical description of the plant and its operation

    - Summary of details about your installation.
    - Summary of operational activities.
- ✓ Any other Information
- ✓ Signatures and declaration
- ✓ Submitting the Application
- ✓ Advertising your Application

As an example of an explanatory note on an administrative issue, as provided by the EPA in the UK, the following is presented below /6/:

Example of a Data Protection Notice

”The information you give will be used by the Environment Agency to process your application. It will be placed on the relevant public register(s), and used to monitor compliance with licence/permit conditions, or to process renewal applications. We may also use and/or disclose any of the information you give us in order to:”

- *offer/provide you with our literature/services relating to environmental matters;*
- *consult with the public, public bodies and other organisations (for example Health and Safety Executive, local authorities, emergency services, DEFRA on environmental issues);*
- *carry out statistical analysis, research and development on environmental issues;*
- *provide public register information to enquirers;*
- *investigate possible breaches of environmental law and take any resulting action;*
- *prevent breaches of environmental law;*
- *assess customer service satisfaction and improve our service.*

”We may pass on the information to agents/representatives, whom we ask to do any of these things on our behalf. Individuals have a right to see the information we hold about them. We will correct it if it is inaccurate.”

”You should ensure that any persons named on this form are informed of the contents of this data protection notice.”

”The law says we must place your application on the public register unless you provide good reasons why it should stay confidential. If you want any of the information in your application to remain confidential, enclose a letter with the completed application, giving your reasons in full.”

”We will let you know within 14 days if we agree that the information is confidential.”

4.3. Guidance for New Permit Applications

If it is a question of a new Permit, guidance on the following issues should be provided by the Regulator /5/:

- ✓ About the installation
    - Installation timetable for the new Permit Application.
    - Why is the Application being made?
    - Site maps and reports.
    - Impact on the Environment
- ✓ Using existing information when answering these questions

- ✓ Demonstrating that you will meet the required standards
  - Your proposed techniques
  - Your proposed emissions
  - The impact of your proposals on the environment
  - EIA Directive assessments

As an example of an explanatory note for impact assessment, the one provided by the EPA in the UK is given below /6/:

<u>Example of an Explanatory Note on Impact Assessment</u>

"The level of detail provided in the application should correspond to the level of risk to the environment from the emissions of the activities. Installations that have important or sensitive receptors located within the receiving environment, or emit substances of a nature and quantity that could affect environmental receptors, may require more detailed assessment of the potential effects. Where installations release only a low level of emissions and there are no important or sensitive receptors, these sites may not require such detailed assessment."

"Operators should record the facts that support their assessment of the impacts of their activities and provide these with the application. Guidance note H1 Ref 6, and the associated software tool, provides a methodology for making this assessment, which gives further guidance on the nature of the information and the level of detail required. It also provides a method for determining the significance of the impact of a release on the receiving environment. Scaled maps and site plans should be provided as appropriate to show relative locations of receptors, sources and any monitoring points at which measurements have been made on the emissions or the impact of the emissions."

"The extent of the area covered may be local, national or international depending on the size and nature of the installation and the nature of the emissions. The following important and sensitive receptors must be considered as part of the assessment. Any:

- *Habitats Directive site within 10km of the installation, or within 15km of the site of a power plant with thermal input greater than 50MWth (see The Habitats Regulations on page xx);*
- *Habitats Directive site which is downstream of the installation (at any distance) (see The Habitats Regulations on page xx);*
- *Site of Specific Scientific Interest (SSSI or in Northern Ireland ASSI), within 2km of the installation (see The Habitats Regulations on page xx);*
- *Site of Specific Scientific Interest (SSSI), which may be affected by the installation (see The Habitats Regulations on page xx);*
- *human population (e.g. schools, hospitals or neighbouring properties);*
- *cultural heritage site;*
- *sensitive soils;*
- *sensitive watercourses or ground waters;*
- *sensitive area of the atmosphere (e.g. Ozone depletion of stratosphere, air quality management zone or area where an EQS is threatened)."*

"Odour and noise sensitive receptors should have been identified in sections X.X. and Y.Y. of the application."

"Operators should provide evidence that a satisfactory assessment of the potential effects of emissions from the permitted activities has been carried out, and that these impacts are acceptable. This may be done by using the H1 guidance and software tool, and other supporting information as required, to show the effects on the environment resulting from the emissions from the activities. Provide the results of the assessment with your application and summarised below."

4.4. Guidance on the Completion of a Site Report

Guidance on the following issues of the Site Report, should be provided by the Regulator /6/:

- ✓ Introduction
- ✓ Key points
- ✓ Aims of the guidance
- ✓ Site Reports in permit applications
- ✓ The Site Report and other legislation
- ✓ Framework for Site Reports
- ✓ "Initial" conditions at the Site
  - What will the "initial" condition Site Report be used for?
  - What further issues should be considered when collecting information and data for the "initial" condition Site Report?
  - How much and what type of information is required?
  - How should the "initial" conditions be described and presented?
  - Additional considerations
- ✓ Production of the "initial" Site Report
  - Objectives
  - Activities
  - Steps to be followed
    - Readily available background material:
    - Information obtained by desk study research:
    - Information obtained by site reconnaissance:
  - Potential Sources of Information
    - Information the applicant should have available:
    - Available from the Local Authority:
    - Available from the Environment Agency:
    - Available from local libraries or from book shops:
    - Available from The Stationary Office (TSO):
- ✓ Examples of relevant characteristics of contamination, which need to be considered
  - Example characteristics of possible contamination present at the Site;
  - Examples of substances which may be present and their relevant characteristics
- ✓ Example of a simple matrix for possible contamination of a site
  - Key decisions
- ✓ Minimum Reporting Requirements for Phase 1a
- ✓ Factors to be taken into account when refining the conceptual model
- ✓ Some factors to take into account when deciding whether to carry out a more detailed (Phase 2) Site Investigation
- ✓ Minimum Reporting Requirements for IPPC Phase 2 Site Report

- ✓ Decision Summary Sheets
  - Decision Criteria Sheet 1.1: Indicators of Relevant Pollutant Linkages (Phase 1a)
  - Decision Criteria Sheet 1.2: Data Quality Criteria (Phase 1a and 1b)
- ✓ Worked example to explain the completion of the Decision Summary Sheets

As an example of an explanatory note, the one on site plans and reports, as provided by the EPA in Scotland, is given below /34/:

Example of Guidance on the Submission of Site Plans and Reports

*"This question identifies two sets of documents that must be submitted with your application. Firstly, you need to provide a **site report**. This must describe the condition of the site for the part of the installation in respect of which you are applying. The purpose of the site report, as described in more detail in the Practical Guide /33/, is twofold:*

- ✓ *it should provide a point of reference against which later determinations can be made of whether there has been any deterioration of the site;*
- ✓ *it should also provide information on the physical attributes of the site, including consideration of the vulnerability of the site and the extent to which there may be pathways through the site for pollution of the wider environment."*

"You should take account of the findings of your site report in the development of proposals to protect the environment as a whole (these proposals are to be described in response to Sections B2 – B4 as explained below). If appropriate, you may mark relevant information relating to your site report (for example, the location of polluted areas) on the map or plan submitted below."

*"Secondly, you need to provide **suitable maps or plans** showing the location of the site of the installation and the location, and nature of the various activities on that site, and the area of the site covered by the site report. The precise way that this information should be submitted will depend on the size and nature of the installation. The map or plan may comprise more than one part to help make the information clearer and more useful. A typical submission could involve:"*

- ✓ *"An Ordnance Survey map to a scale of 1:10 000 showing the location of the site in the surrounding area by marking the site boundaries in red. You should also outline any other areas of land that you own or occupy in blue."*
- ✓ *"A larger scale (for example 1:2 500) map or plan of the site showing the location of the installation to which your application relates and any other installations on the same site. This should also show all existing development within 250 metres of the boundary of the installation and all infrastructure."*
- ✓ *"A separate schematic plan of the installation to which your application relates. This should:*
  - *identify the various distinct activities identified in the table under question B1.1, and should distinguish between those activities that you operate and those that are operated by other parties if appropriate;*
  - *show the discharge point of any proposed emissions into the surrounding environment;*
  - *if there are any proposed releases to water (both to sewer and/or controlled waters), the plan should identify the site drainage arrangements, discharge points into the*

sewer or controlled waters, and also where and how any effluents from any other on-site activities join the effluent from the installation;

- *give national grid reference details for such emission points;*
- *show clearly the location of the national grid reference that you are asked to provide in response to question A1.3 in Part A of the Application Form."*

The Environmental Permit Application Form issued and utilized by the Finnish Environment Protection Agency has the same structure as the one issued in the UK. It is presented in Appendix 2.

5. STRUCTURE OF GUIDANCE NOTES ON BAT FOR THE FDM SECTOR

The structure of the Guidance Notes should follow the structure of BAT, as outlined in the BREF Document for the FDM Sector, issued by the European Commission in January 2006 /26/. Guidance Notes on general BAT for the whole FDM sector should be included, as well as Guidance Notes on BAT for specific branches of the FDM sector.

The processes and techniques utilized by the FDM sector can be divided into the following 9 main categories:

- Materials reception and preparation
- Size reduction, mixing, and forming
- Separation techniques
- Product processing technology
- Heat processing
- Concentration by heat
- Processing by removal of heat
- Post-processing operations
- Utility processes

Within each of these categories several different unit operations are being applied. In the BREF Document issued by the Commission, 370 different techniques have been described and information on BAT collected and assessed. Most of the techniques have more than one environmental benefit and some have **cross-media effects**. Many address the issues of minimising water consumption and contamination, energy consumption, and total material utilisation, with the consequent minimisation of waste production. Specific Guidance on each separate technique cannot be provided, but specific Guidance on techniques applied by branches of biggest environmental concern and the ones of greatest economic importance for the country or region concerned should be drafted. Operational and management practices may also need further Guidance on how to be implemented and applied.

It is recommended that, if available, information should be provided about e.g. the following /8/:

- The range of applicability of techniques;
- Operating conditions;
- Sampling and analytical methods;
- Statistical data on consumption and emission level data;
- Opportunities for by-product valorisation;
- The costs of investing in and operation of a certain BAT, and the associated direct and indirect savings that can be achieved;
- How seasonal activities affect the technical and economic viability of certain processes and techniques.

Product loss or wastage is a significant benchmark for the food and drink industry and are useful guidelines for an Operator to assess the performance of the installation against industry standards. Improved process control inputs, conditions, handling, storage and effluent generation will minimise waste by reducing off-specification product, spoilage, loss to drain (for example, fitting a level switch, float valve, or flow meter will eliminate waste from overflows), overfilling of vessels, water use and other losses. Typical losses or percentage of wastage and water use ratios are given in the following table:/8/

Table 1: Typical benchmark values for the FDM sector /8/

Subsector	Loss percentage, %	Water use ratio
Liquid milk	0,7 – 1,0	0,6 : 1
Soft drinks	1,0	1 : 1
Brewing	4 – 6 % (post-fermentation)	4 : 1

Selection of process techniques also has a bearing on product loss. While selection is primarily based on product requirements, it will also have implications for pollution. Operators should consider this trade-off when implementing BAT.

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

Table 2: Process monitoring and control equipment /8/

Technique	Application	Outcome
Temperature measurement	Storage and processing vessels, transfer lines, etc.	Reduced deterioration of materials and out-of-specification products
Pressure measurement	Indirect control of other parameters, for example flow or level	Minimise waste from material damaged by shear friction forces
Level measurement	Storage and reaction vessels	Prevent storage overflow of materials and associated wastage from from storage or reaction tanks; minimise waste from transfer losses in inaccurate batch recipes in vessels; and minimise out-of-date stock or production losses due to insufficient material
Flow measurement	Transfer lines	Accurate addition of materials to processing vessels and minimise excessive use of materials and formation of out-of-specification products
	Steam supply	Maintain correct operating temperature and minimise waste from underheated or overheated materials and products
	Cleaning systems	Control and optimise water use, and minimise effluent generation
Flow control	Constant flow valves	Control flow rate to water ring vacuum pumps
	Flow regulators	Control process water flow rates for specific processes

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

Other techniques that the operators should pay attention to and whenever feasible apply BAT-options on are /8/:

- ✓ Materials handling, unpacking and storage;
- ✓ Raw materials selection and preparation;
- ✓ Size reduction;
- ✓ Mixing, blending, and homogenization;
- ✓ Forming, moulding, and extruding;
- ✓ Heat processing;
- ✓ Processing by the removal of heat;
- ✓ Separation and concentration;
- ✓ Cleaning and sanitation;
- ✓ Emission monitoring and control;
- ✓ Waste minimization;
- ✓ Water use;
- ✓ Energy use;
- ✓ Waste recovery, handling and disposal;
- ✓ Product packaging, storage and delivery
- ✓ Management techniques;
- ✓ Environmetal impact monitoring (beyond installation);
- ✓ Closure and decommissioning

As water consumption is one of the key environmental issues for the FDM sector, examples of Guidance on Water Techniques are provided in the following chapter. Other environmental issues of big concern in the FDM sector are energy use, air emissions and solid wastes.

6. TECHNICAL GUIDANCE FOR WATER USE AND WASTEWATER REDUCTION

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

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

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

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

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

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

Advice on cost-effective measures for minimising water can be found in several ”Water Efficiency” references.

The Operator should carry out a regular review of water use (water efficiency audit) at least every 4 years. If an audit has not been carried out in the 2 years prior to submission of the application, and the details made known at the time of the application, then the first audit should take place within 2 years of the issue of the Permit /7,8/.

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

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

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

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

Measures should be in place to minimise the risk of contamination of surface waters or groundwater by fugitive releases of liquids or solids.

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

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

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

In particular, the cost of membrane technology continues to reduce, and they can be applied to individual process streams or to the final effluent from the effluent treatment plant, as appropriate.

In some applications in some sectors, they can supplement (or possibly completely replace) the ETP plant so that most water is recyclable and there is a greatly reduced effluent volume. Where the remaining, possibly concentrated, effluent stream is sufficiently small – and particularly where waste heat is available - further treatment by evaporation can lead to zero aqueous effluent. Where appropriate, the Operator should assess the costs and benefits of using membrane techniques to minimise water usage and effluent discharge.

Water usage for cleaning and washing down should be minimised by:

- ✓ vacuuming, scraping or mopping in preference to hosing down;
- ✓ reusing wash water (or recycled water) where practicable;
- ✓ using trigger controls on all hoses, hand lances and washing equipment.

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

The principles for reducing the use of fresh water are:

- ✓ monitoring the consumption for each unit process;
- ✓ implementing measures to reduce use where appropriate, for example flow restrictions for cleaning ring mains;

- ✓ recycling water within the process from which it issues, by treating it first if necessary.

Where that is not practicable, it should be recycled to another part of the process which has a lower water quality requirement. Recycling should take place in as many positions as possible for:

- ✓ process feed waters,
- ✓ conveyance waters, and
- ✓ wash waters.

To help decide the potential for substituting water from recycled sources, the water quality requirements associated with each use should be identified. Fresh water should only be used for process waters where:

- ✓ food safety and hygiene legislation requires it;
- ✓ process waters where water quality (e.g. pH, hardness, temperature) requirements of specific products (or equipment) is a factor. Tolerance to abnormal levels should be established so that the lowest compatible quality can be used;
- ✓ once-through use of cooling water should be avoided in favour of closed loop systems (where this is not possible the uncontaminated cooling water should be re-used);
- ✓ vacuum pump sealing (note, below, that this can be much reduced or even eliminated);
- ✓ to make up for evaporative losses.

Water-sealed vacuum pumps can account for a considerable water use and the following techniques can be used:

- ✓ cascading seal water through high to low pressure pumps;
- ✓ use of radial fans or centrifugal blowers;
- ✓ upgraded or new modern designs with improved internal recirculation of water within the pump casing.

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

- ✓ Water use should be minimised and wastewater reused or recycled;
- ✓ The contamination risk of process or surface water should be minimized;
- ✓ Wherever possible, closed loop cooling systems should be used and procedures should be in place to ensure that blow-down is minimized;
- ✓ Where any potentially harmful materials are used, measures should be taken to prevent them from entering the water circuit.

7. TECHNICAL GUIDANCE FOR WASTEWATER TREATMENT IN THE FDM SECTOR

The following text has been extracted from the Guidance Reports for the FDM sector, issued by the EPA in the UK /8/

7.1. General Principles

Where effluent is treated off-site at a sewage treatment works it should be demonstrated that:

- ✓ The treatment provided at the sewage treatment works is as good as would be achieved if the emission were treated on-site, based on reduction of load (not concentration) of each substance to the receiving water;
- ✓ Action plans are appropriate to prevent direct discharge of the wastewaters in the event of sewer bypass, (via storm/emergency overflows or at intermediate sewage pumping stations) for example, knowing when bypass is occurring, rescheduling activities such as cleaning or even shutting down when bypass is occurring;
- ✓ A suitable monitoring programme is in place for emissions to the sewer.

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

As a minimum, all emissions should be controlled to avoid a breach of water quality standards, but where another technique can deliver better results at reasonable cost, it will be considered as BAT and should be used. Unless self-evident, calculations and/or modelling to demonstrate this should be carried out as a part of the Application.

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

The Application should include:

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

The plan should be reviewed annually and submitted to the Regulator.

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. Biological treatment can occasionally also be inhibited by concentrated streams and dilution, by mixing streams, can assist the treatment.

Systems should be engineered to avoid emissions to water 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 should be provided.

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. The Operator should justify the choice and performance of the effluent management system for the plant against specific factors.

7.2. Preliminary techniques

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

7.3. Flow balancing and equalisation

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

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

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

7.4. Diversion tanks

The Operator should describe appropriate contingency measures for accidental discharges from the processes that could prove detrimental to the wastewater treatment plant. If a diversion tank is not provided, the Operator should show how potentially detrimental streams are handled without adversely affecting the wastewater treatment plant.

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

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

7.5. Primary treatment

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

Screens

- ✓ Interception of the waste materials by various types of screens should be the first step in decreasing the solids loading of the wastewater. Drains and grates in operational areas should be fitted with catchpots.
- ✓ Subsequent screens should be placed on wastewater streams as near to the process end of the drains as possible.
- ✓ The main types of screens used are static (brushed or run-down screens) coarse or fine, vibrating and rotary screens.
- ✓ The Operator should ensure that screening equipment is correctly maintained. For example, regular observation is required to ensure that there is no physical damage to the screens and that the solids removal/backwash is operating effectively.
- ✓ The Operator should ensure that the screening capacity is large enough to take account of predictable variations in flow rates during day-to-day operations and due to seasonal variations.
- ✓ Overloading may be a factor where surface water drains are connected to the wastewater drainage system above the screening equipment. Subsequent re-routing of the surface water drains after the installation of the screening equipment should take account of the increased loading during wet weather.

- ✓ Flow equalisation preceding screening equipment may be needed to avoid overloading and bypassing the screen.
- ✓ Blinding of screens is a common problem and, if occurring regularly, consideration should be given to increasing the mesh size or improving the cleaning regime. Most screen manufacturers have different mesh sizes available that can be changed relatively easily.

Settlement

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

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

Air flotation

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

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

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

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

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

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

Centrifuges

There are three main types of centrifuges available:

- ✓ Solid bowl
- ✓ Basket

- ✓ Disc–nozzle

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

7.6. Biological treatment

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

The basic alternatives are aerobic and anaerobic biological systems. There are many designs of each. The Operator should justify the choice and performance of the secondary treatment plant against the following factors:

- ✓ Anaerobic treatment alone would not achieve a final effluent quality high enough for discharge to a watercourse.
- ✓ Anaerobic installations should be followed by an aerobic system, as the latter should ensure that the final effluent is well aerated to assist in the breakdown of the remaining BOD.
- ✓ Whereas anaerobic treatment is not viable for low-strength effluents, aerobic processes can be used for both high- and low- strength effluent.
- ✓ 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.
- ✓ Food processing wastewater is often deficient in nitrogen and/or phosphorus needed to support biological activity during treatment. The ideal BOD/nitrogen/phosphorus ratio is about 100/5/1.
- ✓ Excessive levels of phosphorus can also occur, particularly where large quantities of phosphoric acid are used in cleaning. If such wastewater becomes anaerobic during treatment, there is a risk that phosphate-containing constituents could release phosphorus to the final effluent. The use of nitric acid in a process will produce a similar effect, increasing the levels of ammonia in the wastewater.

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

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

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

7.7. Secondary treatment

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

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

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

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

- ✓ Lack of macronutrients. BOD/N/P ratios should normally be maintained at 100/5/1.
- ✓ pH-fluctuations. In the reactor, the pH should be maintained at 6.8–7.5
- ✓ Temperature. In the reactor, the optimum temperature for mesophilic bacteria is 35 – 37 ^{0}C.
- ✓ Lack of micronutrients. Minimum quantities of micronutrients should be maintained, especially for Fe, Ca, Mg and Zn, according to the specific process employed.
- ✓ Significant quantities of fats, oil (especially mineral oil) and greases should be removed prior to the reactor.
- ✓ Physical blockage of the reactor inlet pipe-work. Effective screening and primary treatment are essential.
- ✓ Overloading. Care should be taken to ensure that the original hydraulic and loading design rates do not exceed the manufacturer's recommendations.

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

7.8. Tertiary treatment

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

There are two categories of tertiary treatment processes:

Macrofiltration

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

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

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

Membrane techniques

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

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

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

- ✓ Micro-filtration
- ✓ Ultra-filtration
- ✓ Nano-filtration
- ✓ Reverse osmosis

7.9. Sludge treatment and disposal

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

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

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

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

7.10. Sludge treatment techniques

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

Sludge thickening

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

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

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

- ✓ The efficiency of the dewatering process is affected by the height of the sludge layer, and not by the volume of supernatant above it. Therefore the tank should have a specific aspect ratio favouring a tall and narrow profile rather than a low tank with a large surface area.
- ✓ Depending upon the details of the primary solids/surplus activated sludge (SAS) removal pattern, consideration should be given to two tanks to allow for quiescent settling of one tank, whilst the second is in fill cycle. If this is not possible, arrange the sludge inlet to be near the top of the tank, possibly onto a baffle plate, to minimise hydraulic disturbance.
- ✓ Allow for gentle agitation within the tank (a picket fence thickener within the tank is most commonly used) to help reduce stratification of the sludge and to assist in the release of any entrained gases and water.
- ✓ Residence time within the tank will be entirely dependent upon the nature of the sludges and excessive retention must be avoided to minimise the possibility of anaerobic conditions occurring with consequent odour and corrosion problems.
- ✓ Addition rates to the thickener should be in the range of 20–30 m3 of feed/m2 of surface area/day.

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

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

Sludge dewatering

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

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

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

- ✓ Filter (or plate) presses are batch processes, and can be manually intensive. The "plates" are covered with a suitable filter cloth (dependent upon the application) and the sludge is fed into the plate cavity. The sludge is dewatered under pressure with the filtrate passing through the filter cloth. Once the pressure is released and the plates separated, the cake is either manually scraped off or vibration mechanisms are employed to automate the process. A filter press can produce up to 40% dry solids cake.
- ✓ The belt press is a continuous process with the filter cloth continually running through rollers that forcefully dewater the sludge. Performance optimisation requires regular and specialized maintenance. A belt press can produce up to 35 % dry solids cake. Chemical costs are generally quite high.
- ✓ Centrifuges are also continuous processes that should produce a cake of up to 40 % dry solids for certain sludges. Because of the "closed" nature of the centrifuge, associated odour problems are minimal.
- ✓ The screw press is particularly suited to waste which has a high proportion of primary screenings; the screw press should produce cake of 25–30 % dry solids.

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

8. TECHNICAL GUIDANCE ON THE APPLICATION OF BAT IN DAIRIES

The following text has largely been extracted from the report on BAT in Dairies issued by the EPA in the UK /7/.

8.1. General Features of Dairy Industry

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

- ✓ There are a wide range of unit operations;
- ✓ Some of the unit operations such as pasteurisation, are not well known outside of the immediate industry;
- ✓ The consumer market is becoming more sophisticated and demanding;
- ✓ There is a continual need for new process innovations;
- ✓ Plant and equipment needs to be flexible to respond to changes in demand;
- ✓ Quality of production is paramount

These factors contribute to making the plant and equipment of dairy food production increasingly complex. Associated abatement equipment needs to be equally flexible and adaptable. There is a potential reluctance to invest large capital in an abatement plant, when it may be possible to achieve the same effects by a change in the production process. Thus changes in the process can be seen as opportunities for environmental, as well as economic gains.

The food and dairy marketplace is characterised by:

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

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

The dairy and milk processing industry uses a vast amount of water and generates a huge amount of effluent in maintaining the required level of hygiene and cleanliness. If i.e. there are around 14 000 million litres of milk produced for processing per year in the UK, and for each litre processed roughly 2 litres of effluent is generated, then this produces around 28 000 000 m^3/year of effluent for disposal to sewers or treatment plants. If we consider this effluent to have an average COD strength of 3 000 mg/l, then the total loading would be around 84 000 000 kg COD/year, equivalent to a wastewater load of a population of over 2 million people /7/.

Substantial reductions in the volume of wastewater generated by this sector can be achieved through waste minimisation techniques and tertiary treatment methods. It is, however, imperative that water conservation measures do not lead to unsatisfactory levels of cleanliness, hygiene or product quality.

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

- ✓ salinity where large amounts of salt are used (e.g. cheesemaking);
- ✓ residues and by-products from the use of chemical disinfection techniques;
- ✓ some cleaning products.

Typically food-processing wastewater is high in COD and BOD compared with other sectors and around 10 times stronger than domestic sewage. The COD is directly associated with levels of product in the wastewater and very high levels of COD are therefore an indication of inefficient processing, and high losses. Typical COD-loads of the main dairy products are shown in the table below:

Table 3: Typical COD-loads of dairy products /7/

Dairy product	**COD mg/l**
Whole milk	220 000
Semi-skimmed milk	165 000
Skimmed milk	105 000
Buttercream 42% BF	1 323 000
Cream 16% BF	475 000
Raw whey	82 000
Separated whey	62 000
Skim concentrate 52% TS	415 000
Fruit youghurt (average)	~350 000
Butter	2 430 000

Whilst relatively high levels are inevitable in many cases, preventing milk and milk products from unnecessarily entering the wastewater system and optimising the chemical use can make a significant difference. Suspended solids concentrations in dairy processing wastewaters also vary depending on processing conditions used within the factory. Wastewater from the dairy sector and from the manufacture of oily foods such as margarine and salad dressings also have high concentrations of fats, oils and greases (FOG). FOG may be “free” i.e. physically separate from the aqueous phase or emulsified.

Dairy wastewaters vary from the highly alkaline (pH 11) to the highly acidic (pH 3.5), depending on the cleaning regimes and types of chemicals used. Factors affecting wastewater pH include:

- ✓ The natural pH of the raw material; e.g. whey can have a pH of between 4.3 and 6.0
- ✓ Use of caustic or acid solution in cleaning operations;

- ✓ Acidic waste streams (e.g. acid whey);
- ✓ Acid-forming reactions in the wastewater (e.g. fermentation reactions from degrading milk content);
- ✓ Nature of raw water source (hard/soft).

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

In addition to the various sector-specific BREFs and techniques, guidance on cost-effective effluent treatment methods and systems can be found in a large variety of documents on water efficiency.

8.2. BAT Issues to be covered

In the Technical Guidance Document for Dairies issued by the EPA in the UK the following general and technical issues have been covered /7/:

- ✓ Main activities and abatement
  - In-process controls
  - Materials handling, unpacking and storage
  - Pasteurisation, Sterilisation and UHT
  - Evaporation
  - Drying
  - Centrifugation and Bactofugation
  - Membrane Separation
  - Ion Exchange
  - Filtration
  - Chuming
  - Cooling and Chilling
  - Freezing and Blast Cooling
  - Mixing, Blending and Homogenisation
  - Filling
  - Fermentation/Incubation Process
  - Cleaning and Sanitation
- ✓ Abatement of Point Source Emissions
  - Abatement of point source emissions to air
  - Abatement of point source emissions to surface water and sewer
  - Abatement of point source emissions to groundwater
  - Control of fugitive emissions to air
  - Control of fugitive emissions to surface water, sewer and groundwater
  - Odour
- ✓ Management techniques
- ✓ Raw Materials
  - Raw materials selection
  - Waste minimization
  - Water use
- ✓ Waste handling
- ✓ Waste recovery or disposal
- ✓ Energy

- Basic energy requirements
- Further energy-efficiency requirements

✓ Accidents

✓ Noise

✓ Monitoring

- Emissions monitoring
- Environmental monitoring (beyond installation)

As an example of the level of details provided, the guidance notes on in-process controls in dairies are presented in the following section.

8.3. Guidance on In-Process Controls

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

Product loss or wastage is a significant benchmark for the dairy industry and is a useful guideline for an operator to assess the performance of the installation against industry standards. In assessing the wastage efficiency of milk processing sites, two coefficients are used to measure milk loss and water usage /6/:

- % COD (or milk) loss to effluent (measured as COD)
- Effluent to Milk Intake Ratio (or Water to Milk Intake Ratio)

These techniques have been used for many years, and have proven themselves much more accurate than trying to assess the percentage of milk loss, using yield calculations or mass balances, which are still used by the majority of the dairy companies in the UK. Mass balance or yield figures often give negative variances (milk is gained instead of lost – which is clearly impossible), whereas this never occurs, when actually measuring the loss to effluent using % COD loss techniques.

Good wastage coefficients for simple milk processing sites would be around 1.5 % milk loss to effluent and a 1,5:1 effluent to milk ratio. Some sites with excellent wastage management can (and do) achieve less than 1 % milk loss to effluent and an effluent to milk ratio of 1:1, or less. Sites with poor wastage management, or inefficient processing profiles, can have losses in excess of 5 % milk loss.

Clearly, these figures can only be a guide, as actual wastage performance depends on many other factors, including product type and mix, processing profiles, plant utilisation efficiency, age of processing equipment and control systems, and effluent pressure. Using these techniques as part of the wastage monitoring for the site, will allow the operator to demonstrate historical wastage performance and highlight improvements, as part of an overall wastage control campaign.

The factors that influence wastage control on a dairy include, but are not limited to the following:

✓ Management awareness and motivation to improve wastage;

✓ Operators' awareness;

✓ Measurement of losses;

✓ Constraints on the effluent disposal route;

- ✓ Process design of the CIP systems;
- ✓ Plant utilisation efficiency and downtime;
- ✓ Willingness to invest time, money and efforts.

The following steps should be followed for controlling the operation:

- ⇒ Determine the size of the problem - this requires effluent monitoring to be set up to provide information on wastewater loadings (kg COD and volume). This information can be converted into product or money equivalents, and the loss coefficients mentioned above can be calculated. *"If you're not monitoring it, you can't manage it"*
- ⇒ Set targets, objectives and EPI's (Environmental Performance Indicators) - this could be a reduction in daily kg COD or volume, a percentage reduction in Trade Effluent Charges, or any other specific objective. As with all objectives, the target should be measurable, realistic, and agreed upon, by those who are going to implement it, and it should be achievable.
- ⇒ Investigate/isolate high loss areas - this is often where factory personnel provide the best input for suggestions and information. Specific machines or departments can be assessed or a complete factory effluent audit conducted, itemising the effluent loadings from all manufacturing and cleaning processes.
- ⇒ Catching people doing things RIGHTLY can be a key to ensuring their commitment and interest.
- ⇒ Action - this stage may mean an input of capital or revenue expenditure for pipe-work or recovery systems, but this can be offset against the potential savings. All financial input should have a return on investment, and following completion this should be audited to prove the savings. Often changes in working practices or techniques will provide savings without the need for any additional expenditure.
- ⇒ Continue monitoring and review - has the action worked? Have we reached targets? Do we re-set our targets for further improvements?
- ⇒ Selection of process techniques also has a bearing on product loss. While selection is primarily based on product requirements, it will also have implications for pollution. Operators should consider this trade-off when implementing BAT.

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

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

In the following chapters a few examples of horizontal guidance on certain technical issues relevant for the FDM Sector are given.

9. HORIZONTAL GUIDANCE ON INDUSTRIAL COOLING SYSTEMS

The following text has been taken from the guidance document on industrial cooling systems issued by the European Commission /23/.

9.1. General Aspects and Principles

The integrated BAT approach considers the environmental performance of a cooling system in the context of the overall environmental performance of an industrial process. It aims at minimisation of both the indirect and direct impacts of the operation of the system. It is based on the experience that the environmental performance of cooling of a process largely depends on selection and design of the cooling system. Therefore, for new installations the approach focuses on prevention of emissions by selection of an adequate cooling configuration and by proper design and construction of the cooling system. Additionally, reduced emissions are achieved by optimization of daily operation.

For existing cooling systems there is on a short term less potential for prevention by technological measures and emphasis is on emission reduction by optimized operation and systems control. For existing systems a large number of parameters, such as space, availability of operating resources and existing legislative restrictions, may be fixed and leave few degrees of freedom to change. However, the general BAT approach can be considered as a long-term goal, which fits with equipment replacements cycles for existing installations.

The BAT approach acknowledges that cooling is an essential part of many industrial processes and should be seen as an important element in the overall energy management system. The efficient use of energy in industrial processes is very important from the environmental and cost-efficiency points of view. First of all, BAT means that attention must be paid to the overall energy efficiency of the industrial or manufacturing process, before measures are taken to optimize the cooling system. To increase overall energy efficiency, industry aims to reduce the amount of non-recoverable heat by applying proper management of energy and by adopting a range of integrated energy-saving programmes. This includes energy exchange between different units inside the cooled industrial or manufacturing process, as well as links outside this process with adjacent processes. There is a tendency towards a concept of heat recovery for industrial regions when industrial sites are interlinked or are linked with district heating or greenhouse farming. Where no further recovery and re-use of this heat is possible, it may haveto be released into the environment.

Distinction is made between low level (10-25ºC), medium level (25-60ºC) and high level (60ºC) non-recoverable heat. In general, wet cooling systems are applied for low level heat and dry cooling systems for high level heat. For the medium level no single cooling principle is preferred and different configurations can be found.

After optimization of the overall energy efficiency of the industrial or manufacturing process a given amount and level of non-recoverable heat remains and a first selection for a cooling configuration to dissipate this heat can be made balancing:

- ✓ the cooling requirements of the process,
- ✓ the site limitations (including local legislation) and
- ✓ the environmental requirements.

The cooling requirements of the industrial or manufacturing process must always be met to ensure reliable process conditions, including start-up and shut down. The required minimum process temperature and the required cooling capacity must be guaranteed at all times so as to enhance the efficiency of the industrial or manufacturing process and reduce the loss of product and emissions to the environment. The more temperature sensitive these processes, the more important this will be.

Site conditions limit the design options and the possible ways a cooling system can be operated. They are defined by the local climate, by the availability of water for cooling and discharge, by the available space for constructions and by the sensitivity of the surrounding area to emissions. Depending on the process demands on cooling and the required cooling capacity, site selection for a new installation can be very important (e.g. large cold water source). Where the choice for a site is driven by other criteria or in the case of existing cooling systems, the cooling requirements of the process and the site characteristics are fixed.

For cooling, the local climate is important, as it affects the temperature of the ultimate coolant water and air. The local climate is characterised by the pattern of wet and dry bulb temperatures. In general, cooling systems are designed to fulfil the cooling requirements under the least favourable climatic conditions that can occur locally, i.e. with highest wet and dry bulb temperatures.

The next step in the selection and design of the cooling system aims to meet the BAT requirements, within the requirements of the process to be cooled and the site limits. This means that emphasis here is on the selection of adequate material and equipment to reduce maintenance requirements, to facilitate operation of the cooling system, and the realisation of environmental requirements. Besides the release of heat into the environments other environmental effects can occur, such as the emission of additives used for conditioning of cooling systems. It is emphasized that where the amount and level of heat to be dissipated can be reduced, the resulting environmental impact of the industrial cooling system will be lower.

The principles of the BAT approach can also be applied to existing cooling systems. Technological options may be available, such as a change of cooling technology, or a change or modification of existing equipment or chemicals used, but they can only be applied to a limited extent.

9.2. Cooling Systems

Cooling systems are based on thermodynamic principles and are designed to promote the heat exchange between process and coolant and to facilitate the release of non-recoverable heat into the environment. Industrial cooling systems can be categorized by their design and by the main cooling principle: using water or air, or a combination of water and air as coolants. The exchange of heat between process medium and coolant is enhanced by heat exchangers. From the heat exchangers the coolant transports the heat into the environment.

In open systems the coolant is in contact with the environment. In closed systems the coolant or process medium circulates inside tubes or coils and is not in open contact with the environment.

Once-through systems are commonly applied to large capacity installations in locations where sufficient cooling water and receiving surface water are available. If a reliable water source is not available, recirculating systems (cooling towers) are used.

In open recirculating towers, cooling water is cooled down by contact with an airstream. Towers are equipped with devices to enhance the air/water contact. The airflow can be created by mechanical draught using fans or by natural draught. The mechanical draught towers are used widely for small and large capacities. Natural draught towers mostly are applied for large capacities (e.g. power industry).

In closed circuit systems the tubes or coils in which the coolant or process medium circulates are cooled, in turn cooling the substance they contain. In wet systems an airflow cools by evaporation the tubes or coils which are sprayed with water. In dry systems only an airflow passes the tubes/coils. In both designs coils can be equipped with fins, enlarging the cooling surface and thus the cooling effect. Closed circuit wet systems are widely used in industry for smaller capacities. The principle of dry air-cooling can be found in smaller industrial, as well as in large power plant applications in those situations, where sufficient water is not available or water is very expensive.

Open and closed hybrid cooling systems are special mechanical tower designs, which allows wet and dry operation to reduce visible plume formation. With the option of operating the systems (in particular small cell-type units) as dry systems during periods of low ambient air temperatures, a reduction in annual water consumption and visible plume formation can be achieved.

The end temperature of the process medium leaving the heat exchanger after cooling depends on the coolant temperature and on the design of the cooling system. Water has a higher specific heat capacity than air and therefore is the better coolant. The temperature of the coolant air and water depend on the local dry and wet bulb temperatures. The higher the bulb temperatures the more difficult it is to cool down to low end temperatures of the process.

The end temperature of the process is the sum of the lowest ambient (coolant) temperature and the minimum required temperature difference between coolant (entering the cooling system) and process medium (leaving the cooling system) over the heat exchanger, which is also called the (thermal) approach. Technically the approach can be very small by design, but costs are inversely proportional to the size. The smaller the approach the lower the process end temperature can be. Each heat exchanger will have its approach and, in the case of additional heat exchangers, in series, all approaches are added to the temperature of the coolant (entering the cooling system) to calculate the achievable end temperature of the process. Additional heat exchangers are used in indirect cooling systems, where an extra cooling circuit is applied. This secondary circuit and the primary cooling circuit are linked by a heat exchanger. Indirect cooling systems are applied where leakage of process substances into the environment must be strictly avoided.

For the cooling systems commonly applied in the power industry, minimum approaches and cooling capacities are somewhat different from non-power plant applications because of the special requirements of the steam condensation process. The different approaches and relevant power generating capacities are summarized in the table below.

Table 4: Examples of capacity and thermodynamic characteristics of different cooling systems for applications in power industry /23/

Cooling System	Applied approaches (K)	Capacity of power generating proces (MWth)
Open once-through systems	13 – 20 (3- 5)	< 2 700
Open wet cooling tower	7 – 15	< 2 700
Open hybrid cooling tower	15 – 20	< 2 500
Dry air-cooled condenser	15 - 25	< 900

9.3. Environmental aspects

The environmental aspects of cooling systems vary with the applied cooling configuration, but the focus is predominantly on increasing the overall energy efficiency and on the reduction of emissions to the aquatic environment. The consumption and emission levels are very site-specific and where it is possible to quantify them they show large variation. In the philosophy of an integrated BAT approach, cross-media effects must be taken into account in the assessment of each environmental aspect and the associated reduction measures.

Energy consumption

The specific direct and indirect consumption of energy is an important environmental aspect relevant for all cooling systems. The specific indirect energy consumption is the energy consumption of the process to be cooled. This indirect energy consumption can increase due to a sub-optimal cooling performance of the applied cooling configuration, which may result in a temperature rise of the process.

The specific direct energy consumption of a cooling system is expressed in kW_e/MW_{th} and refers to the amount of energy consumed by all energy consuming equipment (pumps, fans) of the cooling system for each MW_{th} it dissipates.

Measures to reduce the specific indirect energy consumption are:

- ✓ to select the cooling configuration with the lowest specific indirect energy consumption (in general once through systems),
- ✓ to apply a design with small approaches, and
- ✓ to reduce the resistance to heat exchange by proper maintenance of the cooling system.

To reduce the specific direct energy consumption, pumps and fans with higher efficiencies are available. Resistance and pressure drops in the process can be reduced by design of the cooling system and by application of low resistance drift eliminators and tower fill. Proper mechanical or chemical cleaning of surfaces will maintain low resistance in the process during operation.

Water

Water is important for wet cooling systems as the predominant coolant, but also as the receiving environment for cooling water discharge. Impingement and entrainment of fish and other aquatic organisms occur with large water intakes. Discharge of large amounts of warm water can also influence the aquatic environment, but the impact can be controlled by suitable location of intake and outfall, and assessment of tidal or estuarine flows, to insure adequate mixing and advective dispersion of the warm water.

Consumption of water varies between 0.5 $m^3/h/MW_{th}$ for an open hybrid tower and up to 86 $m^3/h/MW_{th}$ for an open once-through system. Reduction of large water intakes by once-through systems requires a change towards recirculating cooling. At the same time it will reduce the discharge of large amounts of warm cooling water and may also reduce emissions of chemicals and waste. The water consumption of recirculating systems can be reduced by increasing the number of cycles, by improving the water make-up quality, or by optimizing the use of waste water sources available on or off site. Both options require a complex cooling water treatment programme. Hybrid cooling, which allows dry cooling during some periods of the year, with a lower cooling demand or with low air temperatures, can reduce water consumption in particular for small cell-type units.

Design and positioning of the intake and various devices (screens, barriers, light, sound) are applied to reduce the entrainment and impingement of aquatic organisms. The effect of the devices depends on the species. Costs are high and measures are preferably applied in a greenfield situation. Lowering the required cooling capacity if possible by increasing the reuse of heat may reduce emissions of warm cooling water to the receiving surface water.

<u>Water emissions</u>

Emissions of heat into surface water can have environmental impact on the receiving surface water. Factors of influence are e.g. the available cooling capacity of the receiving surface water, the actual temperature and the ecological status of the surface water. Emissions of heat can result in the exceeding the EQS for temperature during warm summer periods as a consequence of heat discharges into the surface water resulting from cooling water.

For two ecological systems (Salmonid waters and Cyprinid waters) thermal requirements have been taken up in Directive 78/659/EEC. Relevant for the environmental impact of heat emissions is not only the actual temperature in the water, but also the temperature rise at the boundary of the mixing zone as a consequence of the heat discharge into the water. The amount and level of the heat discharged into the surface water related to the dimensions of the receiving surface water are relevant to the extent of the environmental impact. In situations where heat discharges at relatively small surface waters and the hot water plume reaches the opposite side of the river or canal this can lead to barriers for the migration of Salmonides.

Besides these effects high temperature as a consequence of heat emissions can lead to increased respiration and biological production (eutrophication) resulting in a lower concentration of oxygen in the water.

When designing a cooling system the above aspects and the possibilities to reduce the heat dissipated into the surface water have to be taken into account.

Particulate emissions into the surface water from cooling systems are caused by:

- ✓ applied cooling water additives and their reactants,
- ✓ airborne substances entering through a cooling tower,
- ✓ corrosion products caused by corrosion of the cooling systems' equipment, and
- ✓ leakage of process chemicals (product) and their reaction products.

Proper functioning of cooling systems may require the treatment of cooling water against corrosion of the equipment, scaling and micro- and macrofouling. Treatments are different for open once-through and recirculating cooling systems. For the latter systems, cooling water treatment programmes can be highly complex and the range of chemicals used can be large. As a consequence, emission levels in the blowdown of these systems also show large variation and representative emission levels are difficult to report. Sometimes the blowdown is treated before discharge.

Emissions of oxidizing biocides in open once-through systems, measured as free oxidant at the outlet, vary between 0.1 [mg FO/l] and 0.5 [mg FO/l] depending on the pattern and frequency of dosage.

Selecting and applying cooling equipment that is constructed of material suitable for the environment in which it will operate can reduce leakage and corrosion. This environment is described by:

- ✓ the process conditions, such as temperature, pressure, flow speed,
- ✓ the media cooled, and
- ✓ the chemical characteristics of the cooling water.

Materials commonly used for heat exchangers, conduits, pumps and casing are carbon steel, copper-nickel and various qualities of stainless steel, but titanium (Ti) is increasingly used. Coatings and paints are also applied to protect the surface.

Open once-through systems are predominantly treated with oxidizing biocides against macrofouling. The amount applied can be expressed in the yearly used oxidative additive expressed as chlorine-equivalent per MW_{th} in connection with the level of fouling in or close to the heat exchanger. The use of halogens as oxidative additives in once-through systems will lead to environmental loads primarily by producing halogenated by-products.

In open recirculating systems, pretreatment of water is applied against scaling, corrosion and micro-fouling. With the relatively smaller volumes of recirculating wet systems alternative treatments are successfully applied, such as ozone and UV light, but they require specific process conditions and can be quite costly.

Operational measures reducing harmful effects of cooling water discharge are the closing of the purge during shock treatment and the treatment of the blowdown before discharge into the receiving surface water. For treatment of blowdown in a wastewater treatment facility the remaining biocidal activity must be monitored as it may affect the microbial population.

To reduce the emissions in the discharge and to reduce the impact on the aquatic environment, biocides are selected which aim to match the requirements of the cooling systems with the sensitivity of the receiving aquatic environment.

Emissions to air

The discharged air from dry circuit cooling towers is usually not considered as the most important aspect of cooling. Contamination may occur if there is a leak of product, but proper maintenance can prevent this.

The droplets in the discharge of wet cooling towers can be contaminated with water treatment chemicals, with microbes or with corrosion products. The application of drift eliminators and an optimized water treatment programme reduce potential risks.

Plume formation is considered where the horizon-marring effect occurs or where risk exists of the plume reaching ground level.

Noise

The emission of noise is a local issue for large natural draught cooling towers and all mechanical cooling systems. Unattenuated sound power levels vary between 70 dB for natural draught and about 120 dB for mechanical towers. Variation is due to differences in equipment and to place of measurement as it differs between air inlet and air outlet. Fans, pumps and falling water are the major sources.

Risk aspects

Risk aspects of cooling systems refer to leakage from heat exchangers, to storage of chemicals and to microbiological contamination (such as legionnaire's disease) of wet cooling systems. Preventive maintenance and monitoring are applied measures to prevent leakage as well as microbiological contamination. Where leakage could lead to discharges of large amounts of substances harmful to the aquatic environment, indirect cooling systems or special preventive measures are considered.

For prevention of the development of *Legionellae pneumophila* (*Lp*) an adequate water treatment programme is advised. No upper concentration limits for *Lp*, measured in colony forming units [CFU per liter], could be established below which no risk is to be expected. This risk has to be particularly addressed during maintenance operations.

Solid residues

Little has been reported on residues or wastes. Sludges from cooling water pretreatment or from the basin of cooling towers have to be regarded as waste. They are treated and disposed of in different ways depending on the mechanical properties and chemical composition. Concentration levels vary with the cooling water treatment programme.

Environmental emissions are further reduced by applying less harmful conservation methods for equipment and by selecting material that can be recycled after decommissioning or replacement of cooling systems' equipment.

9.4. BAT assessment

It is acknowledged that the final BAT solution will be a site-specific solution, but for some issues techniques could be identified as general BAT. In all situations the available and applicable options for reuse of heat must have been examined and used to reduce the amount and level of non-recoverable heat, before the dissipation of heat from an industrial process into the environment is considered.

For all installations BAT is a technology, method or procedure and the result of an integrated approach to reduce the environmental impact of industrial cooling systems, maintaining the balance between both the direct and indirect impacts. Reduction measures should be considered maintaining at minimum the efficiency of the cooling system or with a loss of efficiency, which is negligible, compared with the positive effects on the environmental impact.

For a number of environmental aspects, techniques have been identified that can be considered BAT within the BAT approach. No clear BAT could, however, be identified on the reduction of waste or on techniques to handle waste, while avoiding environmental problems such as contamination of soil and water or, with incineration, of air.

Selection between wet, dry and wet/dry cooling to meet process and site requirements should aim at the highest overall energy efficiency. To achieve a high overall energy efficiency when handling large amounts of low level heat (10-25ºC) it is BAT to cool by open once-through systems. In a greenfield situation this may justify selection of a (coastal) site with reliable large amounts of cooling water available and with surface water with sufficient capacity to receive large amounts of discharged cooling water.

Where hazardous substances are cooled that involve a high risk to the environment (emitted via the cooling system), it is BAT to apply indirect cooling systems using a secondary cooling circuit.

In principle, the use of groundwater for cooling has to be minimized, for instance where depletion of groundwater resources cannot be ruled out.

Low direct energy consumption by the cooling system is achieved by reducing resistance to water and/or air in the cooling system, by applying low energy equipment. Where the process to be cooled demands variable operation, modulation of air and water flow has been successfully applied and can be considered BAT.

The reduction of water consumption and the reduction of heat emissions to water are closely linked and the same technological options apply.

The amount of water needed for cooling is linked to the amount of heat to be dissipated. The higher the level of reuse of cooling water, the lower the amounts of cooling water needed. Recirculation of cooling water, using an open or closed recirculating wet system, is BAT, where the availability of water is low or unreliable. In recirculating systems an increase of the number of cycles can be BAT, but demands on cooling water treatment may be a limiting factor. It is BAT to apply drift eliminators to reduce drift to less than 0.01% of the total recirculating flow.

Many different techniques have been developed to prevent entrainment or to reduce the damage in case of entrainment. Success has been variable and site-specific. No clear BAT have been identified, but emphasis is put on an analysis of the biotope, as success and failure much depend on behavioural aspects of the species, and on proper design and positioning of the intake.

In line with the BAT approach, the application of the potential techniques to reduce emissions to the aquatic environment should be considered in the following order:

1. Selection of cooling configuration with lower emission level to surface water;
2. Use of more corrosion resistant material for cooling equipment;
3. Prevention and reduction of leakage of process substances into the cooling circuit;
4. Application of alternative (non-chemical) cooling water treatment;
5. Selection of cooling water additives with the aim of reducing impact on the environment, and
6. Optimized application (monitoring and dosage) of cooling water additives.

BAT is reducing the need for cooling water conditioning by reducing the occurrence of fouling and corrosion through proper design. In once-through systems, proper design is to avoid stagnant zones and turbulence and to maintain a minimum water velocity (0.8 [m/s] for heat exchangers, 1.5 [m/s] for condensers).

It is BAT to select material for once-through systems in a highly corrosive environment involving Ti or high quality stainless steel or other materials with similar performance, where a reducing environment would limit the use of Ti.

In recirculating systems, in addition to design measures, it is BAT to identify the applied cycles of concentration and the corrosiveness of the process substance to enable selection of material with adequate corrosion resistance.

It is BAT for cooling towers to apply suitable fill types under consideration of water quality (content of solids), expected fouling, temperatures and erosion resistance, and to select construction material which does not need chemical conservation.

The VCI concept applied by chemical industry aims at minimizing the risks for the aquatic environment in case of leakage of process substances. The concept links the level of environmental impact of a process substance with the required cooling configuration and monitoring requirements. With higher potential risks for the environment in case of leakage the concept leads to improved anti-corrosiveness, indirect cooling design and an increasing level of monitoring of the cooling water.

Optimization of the application of oxidizing biocides in once-through systems is based on timing and frequency of biocide dosing. It is considered BAT to reduce the input of biocides by targeted dosing in combination with monitoring of the behavior of macrofouling species (e.g. valve movement of mussels) and using the residence time of the cooling water in the system. For systems where different cooling streams are mixed in the outlet, pulse-alternating chlorination is BAT and can reduce even further free oxidant concentrations in the discharge. In general, discontinuous treatment of once-through systems is sufficient to prevent fouling. Depending on species and water temperature (above 10-12^{0}C) continuous treatment at low levels may be necessary.

For seawater, BAT-levels of free residual oxidant (FRO) in the discharge, associated with these practices, vary with applied dosage regime (continuous and discontinuous) and dosage concentration level and with the cooling system configuration. They range from < 0.1 mg/l to 0.5 mg/l, with a value of 0.2 mg/l as 24h-average.

An important element in introducing a BAT-based approach to water treatment, in particular for recirculating systems using non-oxidizing biocides, is the making of informed decisions about what water treatment regime is applied, and how it should be controlled and monitored. Selection of an appropriate treatment regime is a complex exercise, which must take into account a number of local and site-specific factors, and relate these to the characteristics of the treatment additives themselves, and the quantities and combinations in which they are used.

In order to assist the process of BAT decision making on cooling water additives at a local level, the BREF seeks to provide the local authorities responsible for issuing an IPPC permit with an outline for an assessment.

The reduction of the impact of emissions to air from cooling tower operation is linked to the optimization of cooling water conditioning to reduce concentrations in the droplets. Where drift is the main transporting mechanism, the application of drift eliminators, resulting in less than 0.01% of the recirculating flow being lost as drift, is considered BAT.

Primary measures are applications of low noise equipment. The associated reduction levels are up to 5 [dB(A)]. Secondary measures at inlet and outlet of mechanical cooling towers have associated reduction levels of a minimum of 15 [dB(A)] or more. It must be noted that noise reduction, in particular by secondary measures, can lead to pressure drop, which needs extra energy input to compensate.

All key BAT conclusions can be applied to new systems. Where it involves technological changes, the application may be limited for existing cooling systems. For small cooling towers produced in series, a change in technology is considered to be technically and economically feasible. Technological changes for large systems are generally cost intensive requiring a complex technical and economic assessment involving a large number of factors. Relatively small adaptations to these large systems, changing part of the equipment, may be feasible in some cases. For more extensive changes of technology a detailed consideration and assessment of the environmental effect and the costs may be necessary.

In general, BAT for new and existing systems are similar, where the focus is on reducing environmental impact by improvement of the systems' operation. This refers to:

- ✓ optimization of cooling water treatment by controlled dosage and selection of cooling water additives aiming at reduction of the impact on the environment,
- ✓ regular maintenance of the equipment, and
- ✓ monitoring of operating parameters, such as the corrosion rate of the heat exchanger surface, chemistry of the cooling water and degree of fouling and leakage.

Examples of techniques considered BAT for existing cooling systems are:

- ✓ application of suitable fill to counteract fouling,
- ✓ replacement of rotating equipment by low noise devices,
- ✓ prevention of leakage by monitoring heat exchanger tubes,
- ✓ side stream biofiltration,
- ✓ improvement of the quality of the make up water, and
- ✓ targeted dosage in once-through systems.

Based on what has been concluded above the assessment and identification of BAT for the process of industrial cooling is generally considered as complex and very site- and process-specific, involving many technical and cost aspects and further work is still needed.

10. INDICATIVE BAT REQUIREMENTS FOR MANAGEMENT TECHNIQUES

The following text has been extracted from the guidance report for the FDM sector, issued by the EPA in the UK /8/

10.1. Operations and Maintenance

Effective operational and maintenance systems should be employed on all aspects of the process, whose failure could impact on the environment. In particular there should be:

- ✓ Documented procedures to control operations that may have an adverse impact on the environment;
- ✓ A defined procedure for identifying, reviewing and prioritising items of the plant for which a preventative maintenance regime is appropriate;
- ✓ Documented procedures for monitoring emissions or impacts;
- ✓ A preventative maintenance programme covering the whole plant, whose failure could lead to impact on the environment, including regular inspection of major 'non productive' items such as tanks, pipe-work, retaining walls, bunds, ducts and filters.

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

10.2. Competence and Training

Training systems, covering the following items, should be in place for all relevant staff:

- ✓ Awareness of the regulatory implications of the Permit for the activity and their work activities;
- ✓ Awareness of all potential environmental effects from operation under normal and abnormal circumstances;
- ✓ Awareness of the need to report any deviation from the Permit;
- ✓ Prevention of accidental emissions and actions to be taken, when accidental emissions occur.

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

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

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

Where industry standards or codes of practice for training exist they should be complied with.

10.3. Accidents, Incidents, and Non-Conformance

There should be an accident plan which:

- ✓ Identifies the likelihood and consequence of accidents;

- ✓ Identifies actions to prevent accidents and mitigate any consequences.

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

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

There should be written procedures for investigating incidents, (and near misses) including the identification of suitable corrective action and for following up.

10.4. Organisation

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

The company should adopt an environmental policy and programme which:

- ✓ Includes a commitment to continual improvement and prevention of pollution;
- ✓ Includes a commitment to comply with relevant legislation and other requirements to which the organisation subscribes; and
- ✓ Identifies, sets, monitors and reviews environmental objectives and key performance indicators independently of the Permit.

The company should have demonstratable procedures (e.g. written instructions), which incorporate environmental considerations into the following areas:

- ✓ The control of process and engineering changes on the installation;
- ✓ Design, construction and review of new facilities and other capital projects (including provision for their decommissioning);
- ✓ Capital approval; and
- ✓ Purchasing policy.

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

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

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

The company should have a clear and logical system for keeping records of, amongst others:

- ✓ Policies
- ✓ Roles and responsibilities
- ✓ Targets
- ✓ Procedures
- ✓ Results of audits
- ✓ Results of reviews

11. HORIZONTAL GUIDANCE ON WASTE MINIMISATION

Waste minimisation can be defined simply as: *"A systematic approach to the reduction of waste at source, by understanding and changing processes and activities to prevent and reduce waste"*. A variety of techniques can be classified under the term waste minimisation, from basic housekeeping through statistical measurement, to application of clean technologies. In the context of waste minimisation and this Guidance /8/, 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.

The Operator should carry out a waste minimisation audit at least every 4 years. If an audit has not been carried out in the last two years, prior to the submission of the application, and the details made known at the time of the application, then the first audit should take place within 2 years of the issue of the Permit. The methodology used and an action plan for reducing the use of raw materials should be submitted to the Regulator within 2 months of completion of the audit. The audit should be carried out as follows:

- ✓ 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:
  - o Process mapping
  - o Materials mass balance
  - o Action plan
- ✓ The use and fate of raw materials and other materials, including by-products, solvents and other support materials, such as fuels, catalysts and abatement agents, should be mapped onto a process flow diagram. This should be achieved by using data from the raw materials inventory and other company data as appropriate. Data should be incorporated for each principal stage of the operation, in order to construct a mass balance for the installation.
- ✓ Using this information, opportunities for improved efficiency, changes in process and waste reduction should be generated and assessed. An action plan should then be prepared for implementing improvements to a timescale approved by the Regulator.

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

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

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

- ✓ All avenues for recycling back into the process or as reworked for another process;
- ✓ Composting;

- ✓ Use as animal feed;
- ✓ Other commercial uses;
- ✓ Landspreading, which should be permitted only where the Operator:
    - can demonstrate that it represents a genuine agricultural benefit or ecological improvement;
    - has identified the pollutants likely to be present from a knowledge of the process, materials of construction, corrosion/erosion mechanisms, materials related to maintenance, for both normal and abnormal operation, validated as necessary by the appropriate analytical techniques;
    - has identified the ultimate fate of the substances in the soil.

It should be noted that landspreading will take place under the Waste Management Licensing Regulations, and the Operator should have a plan and justification for this use.

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 and quantified.

12. GUIDANCE ON ENERGY EFFICIENCY

12.1. Purpose of the Guidance

The purpose of this horizontal guidance is to provide supplementary information to assist applicants in responding to the energy efficiency requirements described in the IPPC Sector Guidance Notes.

In particular, the Notes should provide /10/:

- ✓ Further amplification of the interface between the regulatory requirements of IPPC and climate change or direct participant agreements (into the emissions trading scheme), noting that continuing effort will be made to ensure that, as far as possible, the two regimes are complementary, for example for reporting of energy information, and the like;
- ✓ Descriptions of the basic principles of energy efficiency and energy efficiency techniques;
- ✓ Information on the requirements for costs and benefits appraisal of energy efficiency options according to the Regulators' preferred methodology of using discounted cash flow techniques, with appropriate discount rates and project lifetimes;
- ✓ Conversion factors for assessing the environmental impact of the energy consumption.

Key issues of the guidance are summarised below /10/:

- ✓ All installations under the scope of IPPC should meet a set of basic energy requirements for energy efficiency. These include:
  - o Provision of information on energy consumed or generated by the activities within the Permit and the associated direct and indirect carbon dioxide emissions;
  - o Energy management provisions;
  - o A description of the proposed measures for the improvement of energy efficiency in operating and maintenance procedures, control of excessive heating and cooling losses, and building services;
  - o Provision of an energy efficiency plan that identifies energy efficiency techniques that are applicable to the operation of the activities.
- ✓ All installations under the scope of IPPC must also meet additional energy efficiency requirements either through:
  - o Participation in a Climate Change Agreement or Direct Participant Agreement in the Emissions Trading Scheme, or
  - o Compliance with further permit-specific requirements, as determined with the Regulator.

The Regulators should not enforce any part of a Climate Change Agreement (CCA) or Direct Participant Agreement (DPA) of the Emissions Trading Scheme (ETS).

- ✓ When participating, the Operator must provide evidence that the activities within the Permit are covered by a Climate Change Agreement or a Direct Participant Agreement in the Emissions Trading Scheme.
- ✓ The Operator must notify the Regulator within 14 days in the case of any failure to obtain recertification of a Climate Change Agreement or the termination of, or withdrawal from an Emissions Trading Scheme Direct Participant Agreement, or if the permitted activities leave such an agreement.
- ✓ Many energy efficiency techniques result in a net cost saving over the life of the technique. The Regulators consider such techniques to be Best Available Techniques (BAT).
- ✓ The Regulators should assess the efficiency of energy saving measures applied, with the aid of a suitable cost benchmark, such as EUR/tonne CO_2, and in the light of information arising from the Climate Change Agreements and Emissions Trading mechanisms.

The environmental impacts of energy use can be reduced, by implementing technical measures to lower energy consumption, to improve energy efficiency, and to use energy from renewable sources. The implementation of cost-effective, technically proven energy efficiency measures offers the potential to make a significant contribution to the reduction of pollution and its global impacts. Other benefits from the efficient use of energy are reduced depletion of non-renewable resources and potential reductions in the use of other raw materials.

The aim of the energy efficiency requirements of IPPC is to ensure that gross energy inefficiencies are eliminated and that the most effective energy saving opportunities are identified and implemented.

There are usually many options that can be considered for optimising energy efficiency in new installations, or improving energy efficiency within an existing installation. Techniques range from simple measures such as good housekeeping, insulation or motor controls, to more complex measures, such as process integrated heat recovery.

In addition, effective energy management procedures are a vital component to inform cost/benefit-appraisals and to ensure that continuous energy efficiency improvements are made.

12.2. Information on Energy Consumption

Energy consumption information should be provided in the Application for all of the activities included within an IPPC Permit. This should be done by using figures of delivered energy consumption for all energy sources used over a recent 12 months period. The information should be broken down by energy source, to include fuels converted to energy at the installation, heat or power imported directly from external sources (such as the national grid or other direct supplier) and renewable energy sources. Where energy is exported in the form of heat or power from an installation, this information should also be provided.

Energy consumption information should be reported in the same units, MWh, for all fuels to enable ease of comparison. The energy contents of fossil fuel, waste and other residues are often reported on a gross calorific value basis, e.g. GJ/tonne or MJ/m^3. Actual calorific values should be reported where available.

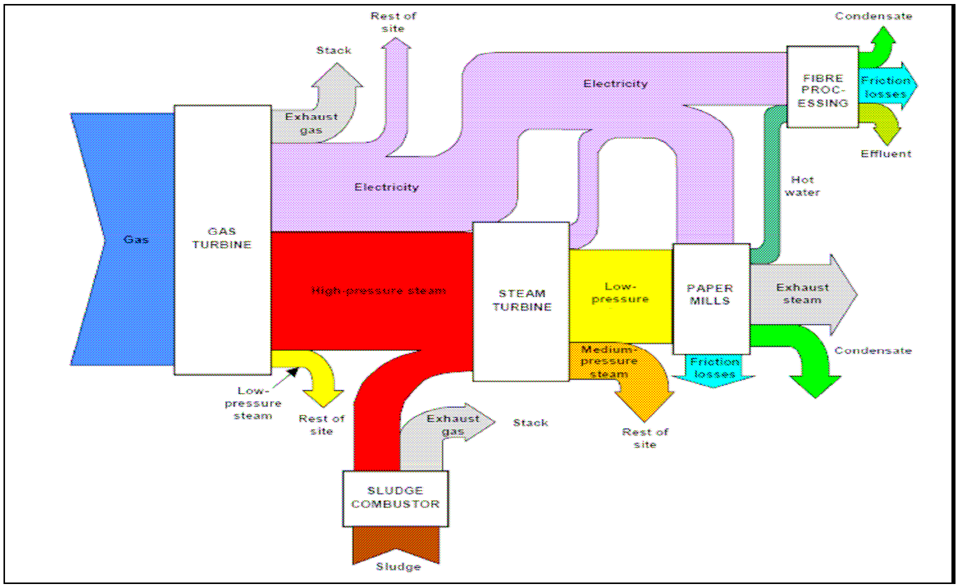
Electricity data should be presented as delivered energy and also converted to primary energy, in order to take into account differences in the efficiency of conversion, generation, supply and transmission by source. For example, electricity imported from the national grid has an overall efficiency of about 40 %, due to heat losses from thermal generation, whereas the efficiency of electricity supplied directly from non-public suppliers may be much higher /10/. Conversion to primary energy ensures that a common basis is used across all IPPC installations and that the advantages of the more efficient conversion systems are taken into account. For conversion of fossil fuel, waste and other residues to energy, no correction is applied to account for energy used in extraction, processing and delivery to the installation.

Units of electricity from the public supply should be multiplied by a factor of 2.6 to account for the energy loss in generation. This factor is consistent with that used by the Government for the purposes of administering energy programmes, including the Climate Change Agreements /10/.

Other factors may be used where heat or power is imported directly from a supplier, or power is generated at the installation, as appropriate. Where this is done, the Operator is required to state the factors assumed, according to the guidelines below /10/:

- ✓ Where electricity is imported from a dedicated electricity generation plant, allocate energy input to the plant to the activities in the Permit on a pro rata basis according to the proportion of electricity consumed by the activities in the Permit.
- ✓ Where energy from a combined heat and power (CHP) plant is used, calculate the units of energy used on the basis of the units of energy input to the CHP plant, not on the units of energy produced by the CHP plant. Where all the energy from a CHP is used within the activities in the Permit, all the units of energy input to the CHP are allocated to the Permit. Where the permitted activities use only part of the output of a CHP, allocate the energy input to the CHP to each user according to separate guidelines.
- ✓ Imported or exported steam should be accounted for by taking the enthalpy (heat content) of the steam and dividing it by the efficiency of the system that generates the steam and distributes it to the user's facility boundary, in order to account for the total energy used to produce the steam. Account should also be taken of steam pressure – for example, where sites import high-pressure steam and return it at a lower pressure.

It is useful to supplement energy consumption information with energy balances (e.g. "Sankey" diagrams, other flow diagrams or descriptions) to illustrate how energy is used throughout the process.



This is particularly relevant where energy conversion is highly integrated within the activities, in order to illustrate any inter-dependencies between energy use and selection of other operational or environmental control measures. This type of information is fundamental to the description of the main activities, and should in most cases be provided in response to the IPPC Application.

Specific energy consumption (SEC) is a benchmark for how much energy is consumed per unit of raw material processed or product output. It is a useful tool for managing energy efficiency, as it takes into account variations in production capacity at an installation, and can be used in an ongoing way to monitor improvements in efficiency within an installation. Some benchmarks are available, for example from the IPPC BREF documents, for industry sectors or specific industrial processes and may be used for comparising the efficiency of installations within a sector. Where available, these will be provided within the sector-specific Guidance Notes. An indicative example of SEC is given in the table below:

Table 5: Specific energy consumption in different industrial sectors /10/

Sector	***Sub-sector / Product***	***Specific Energy Consumption (SEC)***	
		Range	***Units***
Metals	*Copper*	*1,5 – 3,2*	*MWh/ton product*
	Aluminium	*17,8 – 20,0*	*MWh/ton product*
Minerals	*Cement*	*0,9 – 1,8*	*MWh/ton product*
	Lime	*1,5*	*MWh/ton prouct*
Other Industries	*Pulping: Raw pulp*	*5,5 – 5,9*	*MWh/ton product*
	Pulping: Recycled fibre	*2,4 – 2,6*	*MWh/ton product*
	Papermaking	*2,9*	*MWh/ton product*

12.3. Energy Efficiency Plans

The Sector Guidance requires the Operator to produce an energy efficiency plan that identifies and appraises energy efficiency techniques applicable to the activities covered by the Permit.

This is not limited to measures covered under basic energy requirements, but should include all technically available measures, such as those identified in the previous sections, in Sector Guidance or signposted in EEBPP publications /10/. In the case of Permits that are covered by a Climate Change or Direct Participant Agreement, no techniques beyond the basic energy requirements will be enforced by the Regulator. However, if the Permit ceases to be covered by a Climate Change or Direct Participant Agreement, then further energy efficiency measures will be required to meet the PPC Regulations.

The energy efficiency plan submitted as part of the Application will then be used as a basis for determining the scope of these further requirements.

To comply with the requirements of the Sector Guidance, the Operator should provide an energy efficiency plan which:

- ✓ identifies all techniques that are applicable to the installation, but that have not yet been implemented;
- ✓ estimates the annual carbon dioxide savings of each technique, and
- ✓ identifies any techniques that lead to adverse environmental impacts.

In addition, those Applicants, which do not hold a CCA or DPA, should meet the further requirement to:

- ✓ prioritise the applicable techniques according to their costs in relation to the environmental benefit delivered.

The aim of the energy efficiency plan is to provide the basis for an on-going energy efficiency improvement programme. The production of a Permit-specific energy efficiency plan enables the Operator to demonstrate that basic good energy management principles are in place and that the key energy saving opportunities for the installation have been identified and appraised in terms of their costs and benefits. This enables the Operator to identify the scope of measures, which should be implemented, and to prioritise the order of their implementation. (Note that it is likely that this type of appraisal would need to be carried out in any case for the purposes of any targets negotiated under a CCA.)

The most effective energy efficiency improvements can usually be made at the design stage in new installations and refurbishments, or in the specification for procurement of equipment and buildings. At this stage, integrated energy efficiency techniques, such as heat recovery, water minimisation, heat and power demand, can be optimised by consideration of energy consumption and recovery opportunities for the installation as a whole. There are also components and controls of larger equipment or process plant, which can be upgraded or optimised to improve energy efficiency, without the need for major refurbishment or redesign.

The techniques available for energy efficiency are strongly dependent on the particular site, activity and industrial process. There is a vast array of information and advice concerning energy efficiency available commercially, and under the EEBPP run by DEFRA /10/. It should be the aim of this Horizontal Guidance Note, not only to attempt to summarise and reproduce the mass of information here, but to ensure that the Applicant has considered all relevant techniques for energy efficiency within the installation and identified those that are most effective. In many cases, the most appropriate energy efficiency techniques will be described in IPPC Sector Guidance Notes.

13. GUIDANCE ON CONTROL AND MONITORING OF EMISSIONS TO AIR

The PPC regulations require that:

- ✓ Applications for a Permit contain the proposed measures to be taken to monitor the emissions;
- ✓ The Permit includes conditions:
  - o setting out suitable emissions monitoring requirements, specifying the measurement methodology and frequency, and the evaluation procedure, and ensuring that the Operator supplies the Regulator with data required to check compliance with the Permit;
  - o requiring the Operator to supply the Regulator regularly with the results of monitoring.

For some installations the emission limits, monitoring frequencies, averaging times and compliance assessment criteria are specified in the relevant EC Directives. The Directives also require CEN standards for monitoring to be used, where available.

The growing series of IPPC Sector Guidance Notes contain guidance on monitoring requirements and methods based on information derived from the relevant BREFS. The notes describe various sector specific aspects of monitoring. The guidance notes should be adhered to, wherever possible, to ensure consistency across individual sectors.

Continuous monitoring is either required by relevant EC Directives, are desirable where the levels of emissions are environmentally significant or, where continuous monitoring can provide information for improved process control.

13.1. Emission of Particulates and Gaseous Species

Positional requirements should be specified in detail for monitoring particulates and they should take precedence over the requirements for gaseous species, because of the need for isokineticity and the effects of turbulence and flow uniformity. It should be recognised that while well-mixed stack environment is sufficient for representative measurement of gaseous species, excessive turbulence may be detrimental to representative measurement of particulates.

Some process operators consider that the particulate standards are not applicable to their facilities due to the absence of particulate monitoring in the Permit. However, this may not be the case since a percentage of certain species e.g. dioxins, metals, occur in the particulate phase. Monitoring isokinetically for particulates is therefore required and the positional provisions of the particulate standards are relevant /11,12,17/.

On new plants it is essential that the sampling plane is located on a vertical stack with upward flow. If full “glass to glass” monitoring is to be conducted e.g. for metals or dioxins, this is extremely difficult to realise on horizontal (especially circular) ducts.

For the measurements of gaseous species, where isokinetic conditions do not have to be fulfilled, it is enough to verify that no gas concentration stratification takes place. The turbulence and vigorous gas mixing induced by obstructions may in this case be beneficial for representative sampling of gases.

For emissions to air the following data should be collected and reported /27/:

- ✓ Annual total emissions (tons/a) on average, which corresponds to normal operation. The emissions should be separated as point source emissions and non-continuous emissions;
- ✓ The maximum annual emissions (tons/a);
- ✓ The maximum hourly emissions (tons/a);
- ✓ Mean specific emission value (i.e. mg/MJ or g/product ton);
- ✓ The proportion of estimated accidental emissions in relation to total annual emissions and the estimated duration of abnormal operation in relation to annual operational hours.
- ✓ Points of emissions and there height (m);
- ✓ Average content in off-gases (mg/n-m^3);
- ✓ Maximum hourly emissions;
- ✓ The separation efficiency (%) of the filters or the cleaning equipment, planned and guaranteed separation efficiency for each component, and a technical code for the cleaning equipment.

It should also be explained how the emissions are measured and the calculation methods, as well as examples of these should be given in the Permit Application.

The contents of pollutants in flue gases of different types of operation should be converted to dry gases using the following oxygen contents /27/:

- ✓ Boiler plants, solid fuels: 6%
- ✓ Boiler plants, liquid and gaseous fuels: 3%
- ✓ Gas turbines: 15%
- ✓ Waste incineration plants: 11%
- ✓ Asphalt producing plants: 17%

13.2. Horizontal Guidance for Odour Control

The Guidance Notes for Odour Control issued by the EPA in the UK /19, 20/ consists of two parts:

Part 1 - outlines the main considerations relating to the Permitting and Regulation of odour-generating activities. It is aimed primarily at the information needs of Regulators, but also contains information, which will be of use to Applicants. The Note /19/:

- ✓ describes the information relating to odorous releases that is required from the Operator for the purpose of making an Application for a Permit;
- ✓ describes the process of determination as it relates to odour;
- ✓ provides background information relating to the human response to odours; and
- ✓ outlines the tools available for the assessment of the environmental impact of odour.

Part 2 – The Guidance document on Assessment & Control is aimed equally at Regulators and Operators. It describes /20/:

- ✓ a range of odour impact methodologies;
- ✓ the collection of odour samples;

- ✓ the "measurement" of odour – using analytical and sensory techniques;
- ✓ the control of odour by design, and by operational and management techniques; and
- ✓ the range of "end-of-pipe" odour abatement technologies available.

Part 2 provides background information in support of Part 1 and will assist in determining BAT for a given installation.

The aim of an odour impact assessment will be some or all of the following:

- ✓ To predict the exposure of sensitive receptors to odour and to apply a test of acceptability in some form. This could relate to a new or existing plant;
- ✓ To indicate the amount of abatement (or additional abatement) required;
- ✓ To look at trends – improvement or worsening performance over a period of time;
- ✓ To determine compliance with a Permit condition, and
- ✓ Investigating complaints.

There may also be a need to compare the impact or acceptability of different odour abatement options (options appraisal). In the simplest of cases an odour impact assessment will consist of a qualitative estimation of the risk - is it likely to cause a problem, or isn't it? Have there ever been any complaints? Is it possible to detect the odour outside of the installation boundary in areas, which may be frequented by people?

This will usually be sufficient where the risk of causing annoyance is low, provided that a simple justification of the factors considered and the outcome is provided.

As the risk of causing annoyance increases, and the costs of taking corrective action increase and/or a history of odour complaints or annoyance already exists, then so will the need for a more in-depth assessment that takes a more quantitative approach.

Where an existing installation has a history of odour complaints and obvious problems, a detailed odour assessment as part of the application will usually be required. It is important, in terms of cost, effort and the need for a useful output, to match the most appropriate form of assessment to the objectives and purpose of carrying it out in the first place.

If odour impact has never been systematically assessed before, the starting point should be a simple walk over survey of the installation during normal operations. A simple screening assessment should provide a clear indication of whether any potentially significant odour sources exist and whether further, more detailed assessment is required. The "worst case" should also be considered - under what operating conditions are odour emissions worst? Meteorological conditions can also affect odour exposure at receptors and it is useful to walk around beyond the installation boundary under the most adverse conditions - light winds / stable conditions - to see if odour is detectable.

In some cases it will not be possible to measure or to predict emissions at the source in any meaningful way. The emission points may not be well defined – for example there may be a number of fugitive release points, or the emission rate may vary a lot from day to day or hour to hour. It is possible to measure the emission from area sources, but only if the surface is homogeneous. In such cases an assessment may be based upon:

- ✓ the reaction of the people exposed to the odour emission, or where emissions are not too variable:
- ✓ measurements taken in a pattern around the source - odour mapping.

There are a number of situations where an assessment of the community exposure or response might be required:

- ✓ To substantiate complaints or identify/confirm a source;
- ✓ To provide a correlation between community response and certain processes or activities;
- ✓ To determine the extent of the area, the "footprint", over which an odour problem is occuring.

Assessment of the extent of community exposure can be approached in two ways:

a) By gauging the magnitude of the community *response:*

- Complaint records (which are based on past and current experiences)
- Public attitude surveys (based on past exposures)
- Population panels & odour diaries (on-going assessment of current situation).

b) By assessing the magnitude of the *exposure:*

- Analysis of ambient air samples
- Using field panel tests or field judges.

To collect meaningful information relating to what is odorous is generally a very subjective issue, and to separate out the perceived issues from the actual problems, recognised and standardised objective procedures should be used, as far as possible. A number of specific investigative techniques and methods have been documented and some countries such as Germany and the Netherlands have been particularly active, but *standardised* procedures have been slow to develop /24/.

Whilst each assessment will be different and necessarily installation-specific, there are a number of common features, which should be covered in a well-planned and executed survey. Unless the assessment is deliberately targeted at specific events only, or at defined parameters, there will be a need to quantify the emissions in a way, which accounts for any cyclical variation, as well as any seasonal or day/night changes. The impact, in terms of concentration, of those emissions on receptors will then be predicted by means of dispersion modelling and the outcome interpreted in terms of the likelihood of causing annoyance. It is usual to consider both "normal" operation and also "worst case" conditions. The frequency with which worst case conditions arise is also relevant. In some assessments the odour will be "characterised" in addition to a quantitative assessment.

Where the impact of a proposed new plant is being assessed, it will be necessary to describe the location and nature of the proposed operations, but obviously there will be no odour history associated with the plant. Emissions data will have to be predicted by comparison with identical or similar operations and/or mass balance data. Justification should be provided for using particular comparative data. Odour impact contours obviously cannot be transferred directly from an existing installation to a proposed one, as it relies on modelling emissions using local data from the proposed location.

The report may also make recommendations as to the possible measures that could be taken to achieve BAT, both in terms of housekeeping and other management practices and options for odour reduction, by the addition of end-of-pipe abatement equipment. In general terms, the aspects, which should be addressed during the survey, and reflected in the final report, might be categorised as:

- ✓ Summary of findings.

- ✓ A description of the process or the entire installation, its throughput and location.
- ✓ A statement of the objectives of the survey.
- ✓ A description of the methodology used for sampling and analysis.
- ✓ A description of the installation-based work actually undertaken.
- ✓ Monitoring results.
- ✓ Interpretation of the results and conclusions drawn.
- ✓ Recommendations and discussion.

The Guidance Notes for Odour Control issued by the EPA in the UK includes the following text that provides an overview of the type of odour-related information, which will be required from the Operator in his application. There is some variation between sectors, however, according to the type of activities undertaken and the nature of the odour sources associated with those activities.

Where odour could potentially be a problem, the Operator should supply the information as indicated below /19/:

- ✓ *Information relating to sensitive receptors.*
  - o *Type of receptor and location relative to the odour sources*
  - o *An assessment of the impact of odorous emissions on the receptors.*
- ✓ *Where an existing installation has a history of odour complaints and obvious problems, a detailed odour assessment as part of the application will be required.*
  - o *An overview of any complaints received, what they relate to (source/operation) and remedial action taken.*
- ✓ *Inventory of odorous materials/sources and release points.*
  - o *The types of odorous substances used or generated, intentional and fugitive (unintentional) release points and monitoring undertaken.*
- ✓ *Actions taken to prevent or reduce.*
  - o *A description of the actions taken to prevent and/or reduce odour annoyance for each odour source.*
  - o *A demonstration that the indicative BAT requirements are being complied with.*
  - o *Identification of any circumstances or conditions, which might compromise the ability to prevent or reduce odour annoyance, and a description of the actions that will be taken to minimise the impact.*

There may be a requirement placed upon the Operator to provide some or all of this information in the form of an **Odour Management Plan**.

Where the activities do lead to odour emissions, which are detectable beyond the installation boundary, but there is no history of complaints because of remote location or other reason that could be subject to change in the future, the Operator should have due regard to the possibly temporary nature of the situation and ensure that improvement is factored into longer term plans. Significant modifications to the plant should still be expected to meet standards required of a new plant and in any event the general BAT requirement will still apply to the existing plant.

The amount of information supplied and the level of detail should be proportionate to the level of risk of causing annoyance (as can be gained from some knowledge of the previous odour history of the operation). The information supplied must, however, be sufficient to allow the actual level of risk to be determined. Depending on the circumstances, information relating to seasonal or other periodic odour-generating activities, cleaning or maintenance operations etc., which may produce high levels of odour, is particularly important.

14. HORIZONTAL GUIDANCE FOR NOISE

14.1. Purpose and Scope

The purpose of the *IPPC Horizontal Guidance Note for Noise Assessment and Control* is to provide supplementary information, relevant to all sectors, and to assist Applicants in preventing and minimising emissions of noise and vibration, as described in the *IPPC Sector Guidance Notes* (or the *General Sector Guidance Note*).

The guidance document issued by the EPA in the UK /13,14/ is in two parts:

- ✓ Part 1: ***"Regulation and Permitting"*** outlines the main considerations relating to the setting of Permit conditions and subsequent regulation of noise. It is aimed primarily at the information needs of Regulators.
- ✓ Part 2: ***"Noise Assessment and Control"*** describes the principles of noise measurement and prediction, and the control of noise by design, by operational and management techniques, and abatement technologies. It forms a background to Part 1 and will assist in determining BAT for a given installation. It is aimed equally at the Regulator and at Operators.

Regulation of noise under IPPC will bring together several legislative regimes with different scope but similar purpose, and will require a co-ordinated approach between the Regulator and both the Planning functions and the Environmental Health or Environmental Protection Teams of local authorities. At an early stage, lead planning and environmental health/protection officers should be identified to ensure an effective liaison and consultation process.

14.2. Calculating Noise Levels

Whilst measurement is clearly the best means of establishing noise levels in a particular location, this is not always possible. Similarly, it is sometimes difficult to avoid the presence of significant background noise levels when taking measurements. In these cases, it may be necessary to adjust a measured level by calculation to determine the level that is actually of interest. However, sound level prediction can be a complex area and is best undertaken by experienced acousticians.

14.3. Assessment of Noise Impact

There are a number of approaches to noise impact assessment. The method adopted will depend on the purpose of the assessment and its scope – from a site-wide survey to a specific plant or operation.

The following list outlines potential reasons for undertaking assessment work, although there can obviously be a degree of overlap and ultimately there will be a large element of site-specificity in whatever action is taken /14/.

- ✓ *Related to the effect on sensitive receivers:*

  - Assessment of harm potential (possibly as part of a complaint investigation), estimating the likelihood of complaints arising or grounds for reasonable cause for annoyance;
  - Assessment of absolute noise levels;
  - Investigation of the nature and degree of tonal, impulsive or other features of the noise emitted from a source.
- ✓ *Predictive:*
  - Assessing the impact of a new activity or changes to an activity or the addition of abatement equipment.
- ✓ *Determining trends:*
  - Regular long-term monitoring strategy to look at trends, or short samples over a long period - i.e. increase or decrease with time. Unlikely to be continuous monitoring, but more likely to be sample or check monitoring at a specific number of times or days a year.
- ✓ *Determination of compliance with Permit conditions:*
  - Extent and frequency of any alleged or actual breaches and the circumstances relating to those breaches.
- ✓ *Risk assessment/environmental impact assessment:*
  - To support a Permit application a statement of the noise impact of a site and associated history will be required. Additionally, the application will have to demonstrate that BAT has been achieved, or how it is to be achieved. The requirements are set out in the IPPC Guidance Note and the relevant sector-specific guidance note;
  - To provide background information for setting appropriate conditions;
  - To respond to a Permit condition requiring additional information;
  - To ascertain the level of control required or achieved, as a result of actions taken.

Whatever the scale of the issue under investigation is, the overall aim will be to define and carry out a cost-effective and structured investigation to obtain meaningful information relating to the source(s) of noise. The investigation may necessitate sound level monitoring. The sources should be prioritized and decisions made relating to the level and type of controls required. Action plans can then be drawn up and the appropriate trials or work undertaken.

Once the assessment work is complete and mitigation measures have been put into place, ongoing monitoring, maintenance and feedback arrangements are vital to sustained improvement. These form the cornerstone of a **Noise Management Plan**.

14.4. Noise Survey Methodology

The methodology described below is generic and could be applied, with appropriate modification, to a range of activities, both enclosed and open-air, which produce noise. Similarly, it could be applied to a single source in its simplest form, or to an entire process or site, with the intention of producing an integrated noise control strategy.

The key components of noise assessment, that is, the stages involved in identifying sources, quantifying emissions, and assessing control requirements are /14/:

- ✓ Identify the sensitive receptors;
- ✓ Review complaint history;
- ✓ Identify the sources relevant to the complaints or receptors;
- ✓ Carry out an initial risk assessment;
- ✓ Is more information needed?
- ✓ Seek more information;
- ✓ Assess the impact;
- ✓ Is a more stringent level of control required?
- ✓ Identify remedial or improvement actions;
- ✓ Generate options, evaluation/trials, cost-benefit analysis;
- ✓ Carry out modifications;
- ✓ Evaluate/optimize.

14.5. Noise Control - General Principles

Assuming that all management, operational and maintenance issues have been satisfactorily addressed, once noise has been generated, there are a number of physical factors involved in determining how it is propagated and how much reaches the receiver.

Noise levels at sensitive receptors can be minimised by:

- ✓ reduction at source;
- ✓ ensuring adequate distance between the source and the receiver;
- ✓ the use of barriers between the source and the receiver.

In determining the degree of control required, it is usual to calculate or measure the sound pressure level close to the source and, knowing the desired end-point, calculate:

- ✓ the attenuation provided by the environment at the sensitive location;
- ✓ the additional attenuation required.

It is nearly always more cost-effective to consider noise reduction at the design stage, as later modifications are often more expensive, more difficult to install, and may not be as effective.

14.6. Management of Noise

Measures for preventing or minimising noise need to be considered on a process- and perhaps a site-specific operation basis. The preliminary stages of assessing releases arising from the activity should have highlighted the main noise sources and a hierarchy for dealing with these should have been prepared. Emphasis should be on:

- ✓ good process design or redesign. Utilising “low-noise options”, that is, design the problem out rather than relying on “end-of-pipe” abatement to deal with a noise problem;
- ✓ good operating and management practice backed up by an environmental management system.

For a new facility, the obvious time to consider noise control is at the initial planning stage. Similar opportunities may arise during the lifetime of a facility, when planning an extension or when old plant is being replaced. At this stage, potential noise problems can be "designed out". This approach is usually more effective, costs less and can be integrated into other elements of IPPC, such as energy efficiency.

In some cases, there will be planning restrictions governing what can be done on the site and these can limit the options for noise control. In general, however, consideration should be given to the following basic principles:

- ✓ Use of inherently quieter processes.
- ✓ Selection of inherently quiet plant or "low–noise options".
- ✓ Site layout to maximise natural screening, screening by buildings and separation distances.
- ✓ Orientation of directional noise sources away from sensitive receivers.
- ✓ Noise barriers and bunding.

In the case of landfill sites, the design of the filling sequence can influence the extent of noise screening by filled material, and hence can be used to maximise screening for particular noise-sensitive areas. Tree planting may provide effective mitigation of visual impacts, and may psychologically reduce the noise.

For some operational facilities there are effective ways of reducing noise simply by being aware of its presence as an issue for the site, and by adopting appropriate procedures when carrying out everyday activities. Such procedures can be collectively called "noise management" and can be particularly important where substantial noise control has been incorporated in a plant design.

Noise generated in a mechanical plant by the interaction of moving or rotating parts can increase over time, as these parts tend to wear. Specific acoustic attenuators may also degrade and wear out. The following are just a few examples /14/:

- ✓ Fans can go out of balance;
- ✓ Bearings can wear and become noisy;
- ✓ The perforations in duct attenuators can become clogged and the acoustic lining damaged;
- ✓ Ducts can start to rattle;
- ✓ Internal combustion engine silencers can break down and burn out;
- ✓ Acoustic doors may distort or the seals become worn;
- ✓ Resilient linings to hoppers may be eroded away;
- ✓ Acoustic enclosures (including building panels) may become damaged.

All of these sources of increased noise could be avoided by ensuring a satisfactory standard of maintenance.

There are a number of common-sense procedures that can help to reduce noise emissions. Although these tend to be specific to operations at a particular facility, some common examples are listed as follows /14/:

- ✓ Closing doors and windows in noisy buildings and using acoustic enclosures;
- ✓ Ensuring that generator or vehicle engine hatches are kept closed;
- ✓ Locating a mobile plant away from noise–sensitive receivers;
- ✓ Avoiding dropping materials from a height;

- ✓ Switching off plant when not in use;
- ✓ Stockpiling materials (for example, containers) so as to provide acoustic screening between noise sources and receivers;
- ✓ Careful siting, use and volume control of public address systems;
- ✓ Considerate behaviour by the workforce, especially at night, to avoid or minimise shouting, whistling and the like;
- ✓ Arranging delivery or on–site vehicle routes away from sensitive receivers;
- ✓ Use of “smart” reversing alarms, which produce sound at a volume relative to the background level, for example 5 or 10 dB above, rather than at a fixed volume; or
- ✓ Using other safe systems of work, which obviate the need for reversing alarms.

Although the noise–reduction benefits of these practices can be difficult to quantify, they should form a routine part of best practice to reduce overall noise emissions.

The sensitivity of neighbouring areas to noise impacts will vary with the time of day and day of the week. More stringent standards may be applied for the evening and night than for the daytime. The Irish EPA IPC licensing guidance on noise is in line with other guidance in suggesting a 10 dB differential between day and night in the absence of more detailed information /13/. Restricting the operating hours of noisy activities can be an extremely effective way of mitigating community noise impacts and is often used, to great effect, in planning conditions for new facilities. Restricting operating hours may reduce productivity and create operational difficulties, but it need not necessarily require a stopping of all activities on the site. In some cases, it will be possible to schedule noisy operations to the less sensitive weekday daytime periods in order to keep noise emissions to a minimum at night.

In terms of pollution control, the restriction of operations should be regarded as a secondary form of control, as it does not address control at source. For some operations it may, however, be appropriate.

On some sites that are large, or complex, and on others where there is a significant noise issue, then the development of a **Noise Management Plan** can be a very effective tool to ensure that both the Operator and the Regulator adequately address noise issues. The prepared plan may not need to include all the elements in the outline and it may also include other elements specific to the site under consideration.

14.7. Noise Control Practices

Before considering the subject in more detail, it should be remembered that noise can not necessarily be addressed in isolation. For example, reducing the noise emission by a few dB may give rise to increased energy use or may increase the risk of other pollution occurring. All these issues have to be considered and included in the decision process.

Additionally, noise control measures may take up operational space, which could give rise to health and safety issues in confined areas such as plant rooms. Silencers on air-handling plant can cause backpressure, which can itself lead to increased noise elsewhere in the system, and acoustic enclosures can cause overheating. Hence the design of acoustic measures has to be undertaken by experts, often in consultation with the Operator and the manufacturer of the original item of plant.

The most common noise control methods used are known as passive noise control. However, there is a technique for noise reduction known as active noise control (ANC) or anti-noise. ANC uses modern electronics to produce an acoustic signal, similar to the problem noise, but which is out of phase, so it cancels out the original noise. It is still a developing science as processors improve.

14.8. Noise-Control Equipment and Techniques

A number of the noise control and reduction techniques described below may have to be employed to achieve BAT. However, their need may be influenced by the industry sector and the local circumstances, including the risk of environmental harm.

Noise control is a highly developed industry and numerous manufacturers produce a huge range of equipment designed for particular applications. However, there are common types of equipment that use particular techniques and materials to attenuate noise. Ten generic types of noise-control equipment account for the majority of the equipment that is used by the noise control industry. These are listed below /14/:

- ✓ Acoustic enclosures
- ✓ Acoustic louvers
- ✓ Noise barriers
- ✓ Acoustic paneling
- ✓ Acoustic lagging
- ✓ Vibration damping
- ✓ Impact deadening
- ✓ Attenuators
- ✓ Steam and air diffusers
- ✓ Vibration isolation mounts

Whilst vibration damping and isolation mounts control vibration, they can often make a key contribution to noise control. For many noise sources there will be more than one noise-control option.

Noise is often generated by **turbulence** in the flow of gases and fluids in pipes, ducts, or vessels. If solids are moved, for example, in dust or waste extraction, they may cause impact noise, as well as that caused by the air movement. In general terms, the greater the turbulence the greater the noise. Hence reducing the turbulence by smoothing the flow, and reducing velocities and pressures, can be effective at reducing aerodynamic noise.

High pressure releases such as blow-down, exhausts, emergency pressure relief or dump systems can produce very high noise levels for short periods due to strong turbulence in the area where the emerging jet meets the surrounding air. This type of noise is broadband in character with peaks at frequencies determined by the velocity and size of the jet.

Attenuation can be achieved by using a vent silencer that forms a shroud around the area of maximum turbulence and absorbs the energy as a result of repeated internal reflection. About 18dB reduction in output (sound power) can be achieved, with the higher attenuation occurring at higher frequencies. The design will need to take into account not only the efflux velocity and the frequencies at which maximum attenuation is required, but also the permissible pressure drop. It is likely that a high-pressure drop or other restriction to the flow would be unacceptable on an emergency relief system or similar.

An alternative is to reduce the velocity of the jet (where this is feasible), by increasing the diameter or reducing the pressure. Reducing velocity reduces the turbulence and hence the noise, so increasing the diameter of the source can reduce the noise; *but* this could give rise to another noise source. Alternatively, if the expansion is located somewhere back in the system and remote from the atmospheric vent, steps can be taken to absorb the noise energy before it reaches the outlet, although this may not be suitable for an emergency relief system.

Sometimes it is possible to duct the air stream away to a remote location or to a dump tank where buildings and distance may provide some degree of attenuation; or, where control of timing is possible, to discharge at a time least likely to cause annoyance. The health and safety implications to workers, and the environmental impact of the release, will need to be considered by the Operator, as well as the frequency of occurrence. Frequent operation of an emergency system may point to a need for process changes.

Movement around restrictions or obstructions *in ducts* may also create noise. Obstructions or sharp bends can produce turbulence and lead to formation of vortices that produce noise at frequencies determined by the size and shape of the obstruction relative to the flow speed. If any of the noise peaks coincide with the resonant frequency of the system, then amplification can occur and much greater noise levels can result. The solution lies largely in system design, materials of construction, and the velocity of air movement, although absorptive lagging applied to pipe work may provide some degree of attenuation.

Gas control valves used on steam, gas or air systems can generate noise in the valve throat, particularly if supersonic flow conditions are achieved by the combination of flow and orifice size. Reduction of pressure is similarly better undertaken in small graduations, using several valves if appropriate, to avoid supersonic conditions. “Low noise” valves are commercially available. These contain a filter of porous material that serves to slow the velocity and reduce the turbulence around the jet.

In addition to the radiation of noise directly from the valve, associated vibration can be set up in upstream and downstream pipe work and attached structures. This can lead to noticeable "ringing" at the resonant frequency/-ies of the system. Reduction can be achieved by exterior lagging of pipe work with a combination of materials with damping and insulating properties.

Noise produced by cooling jets can be reduced by using a larger–diameter, lower–velocity jet to move the same volume of air. Good practice would be to optimise the combination of mass flow rate, timing and direction of flow. Low-noise nozzles are commercially available, but may suffer a degree of loss of thrust.

15. HORIZONTAL GUIDANCE FOR CROSS-MEDIA EFFECTS AND COST-ASSESSMENT

The following text has been extracted from the report issued by the European Comission /25/.

15.1. Cross-Media Effects

The operation of any IPPC process by its very nature will have environmental effects. To comply with the requirements of the Directive these environmental effects need to be prevented, or where this is not possible they should be minimised to ensure that a high level of protection is given to the environment as a whole. When there are alternative techniques that could be implemented for the IPPC process and there is a choice as to where the resulting pollution is disposed to, the least environmentally damaging option should be chosen. Determining which option is the least environmentally damaging is not always a simple process and there may be trade-offs that have to be made in coming to the decision as to which technique is the best option.

The term ‘Cross-Media effects’ is used to describe the environmental effects of the options under consideration. Choosing between alternative options might require a choice to be made between releasing different pollutants in the same environmental medium (e.g. different technology options might release different air pollutants). In other cases, the choice might be between releasing to different media (e.g. using water to scrub an air emission thereby producing waste water or filtering a water discharge to produce a solid waste).

When determining BAT, most of the cross-media conflicts that are encountered should be relatively simple to understand and it should be easy to come to a decision. In other cases, the trade-offs will be more complex. The purpose of the cross-media methodology set out below is to provide guidance on how to choose which option is best for the environment in these more complex cases. When the methodology is applied it should help to clarify the decision making process and ensure that any conclusions are determined in a consistent and transparent way.

The cross-media methodology will not address local environmental effects, but some screening tools, to help identify the pollutants that are likely to cause the greatest concern in the local situation, may be needed. In many cases, there may be a need to carry out detailed modelling of the fate and effects of the individual pollutants identified by using such a screening tool.

The cross-media methodology consists of four steps:

1. **Scope and identify the alternative options.** The initial step in the process is to scope and identify the alternative options that are available and that could be implemented. The boundaries of the assessment need to be set at this stage, with the normal expectation being that the assessment will be restricted to the boundary of the IPPC process. If at this stage there is sufficient justification to come to a conclusion, the user should stop and set out the justification for the decision.
2. **Inventory of emissions**. This step requires the user to establish an inventory of emissions for each of the alternative options under consideration.
3. **Calculate the cross-media effects.** This step allows the user to express the potential environmental effects anticipated from each of the pollutants within seven environmental themes (e.g. human toxicity, global warming, aquatic toxicity, etc.). This is so that a wide

range of pollutants can either be compared directly or aggregated and expressed as a total effect. Individual pollutants should be summed and expressed as a total potential effect, within each of the seven environmental themes. The user may then be able to compare the alternatives to estimate which option has the lowest potential effect in each theme.

4. **Interpret the cross-media effects.** This final step in the cross-media guidelines discusses how the user can interpret which of the alternative options offers the highest level of protection for the environment. Different approaches for comparing the result of the cross-media assessment can be used.

The degree of uncertainty in the basic data collected for Guidelines 1 and 2 is relatively low compared to the uncertainty after subsequent manipulation, when Guidelines 3 and 4 are applied. The cross-media methodology should be sufficient to come to a decision in most cases. However, it can be a very complex judgement when deriving the solution to which of the alternative options offers the highest level of protection for the environment. To ensure that this methodology is as practical and as usable as possible, it might be necessary to simplify some of the steps that need to be followed when applying it.

Users need to be aware of these simplifications and realise that, in some circumstances, there will also be a need to consider wider issues than just those that are included. Because of these limitations, users will need to accept that there will occasionally be a need for more weight to be given to expert judgement in the assessment process. However, whether applying the full methodology, parts of it, or when using expert judgement, the final decision always needs to be justified to maintain transparency of the decision making process.

The first stage in the cross-media methodology is the definition of the alternative proposals to be considered. It is important that the alternatives are described in sufficient detail to prevent any ambiguity or misunderstanding, either in the scope of the technique or the boundaries of the assessment. Normally the boundaries selected will be those of a typical installation, but if effects outside the boundary of a typical installation are included, this should be clearly stated with an explanation as to why.

In some cases, the aim of using the cross-media methodology is to appraise different techniques or combinations of techniques that deal with control of a specific pollutant, e.g. ‘nitrogen oxides’, ‘particulate emissions’ or ‘biological oxygen demand’. In other cases, where choices exist in the basic technology or process routes, it may be more appropriate to include the whole installation within the scope, including the pollution techniques installed, so that the overall environmental benefits of each option can be compared.

When determining the scope of the assessment and identifying the alternative options, the size or capacity of the proposal will need to be fixed to ensure that the alternatives are compared on an equal basis. It is possible that at this stage, the cross-media conflicts and the different environmental effects may be obvious enough to allow a decision to be made.

At this point, the user should then consider whether there is any need to proceed further with the cross-media methodology, or if there is sufficient justification to support a conclusion. If a conclusion can be reached, then the reasons for that conclusion will still need to be justified and reported, to ensure that the decision making process remains transparent. However, if there is still doubt, as to which alternative provides the greatest level of protection for the environment then the user will need to proceed to the next stage.

The significant environmental releases and the resources consumed by each of the alternative techniques under consideration need to be listed and quantified. This list should cover the pollutants released, the raw materials consumed (including water), the energy used and the wastes produced. The data should be as complete as possible, so that all the emissions, raw material inputs, energy used, and waste produced are accounted for. Both point source and fugitive emissions need to be assessed. For transparency, the details of how the data were derived at or calculated should also be provided. Recording the source of data is also important, so that it can be validated and verified where necessary.

To assess the environmental effects for each of the alternative techniques under consideration, the methodologies set out below allow the different pollutants identified in the inventory to be collated into seven environmental themes. These themes are based on the environmental effects that the pollutants are most likely to cause. Collating the pollutants into themes allows different pollutants to be compared with each other. For each theme, the effect may be only or primarily in one medium, or there may be effects in more than one medium such as air or water. Care needs to be taken to take account of all effects in each case subject to any simplification used.

The themes are:

- ✓ Human toxicity
- ✓ Global warming
- ✓ Aquatic toxicity
- ✓ Acidification
- ✓ Eutrophication
- ✓ Ozone depletion
- ✓ Photochemical ozone creation potential

In a local situation, there are likely to be further evaluations needed and it will also be necessary to ensure that the emissions from the proposal do not compromise environmental quality standards to ensure compliance with Article 10 of the Directive. When making such local decisions, more detailed information about the emissions and the local environment will usually be available and therefore a more detailed assessment can be carried out. This will typically include dilution or dispersion modelling of individual pollutants and an evaluation of their impact on the local environment. Additionally, there may also be issues such as noise, odour and vibrations that also need to be evaluated at an individual installation, but these cannot be easily assessed using this methodology.

Where an obvious conclusion has become apparent from the assessments carried out and providing a sensitivity analysis has been carried out on the key assumptions, the recommendation can be stated with the justification built on the findings from the assessment. If no obvious conclusion has been reached, due to apparent cross-media conflicts, then there may be a need to present the results in a transparent way so that the decision maker can evaluate the relative merits of the alternatives under consideration.

In order to compare the options, and the results of the evaluations carried out so far, three possible approaches are set out below. These approaches may be used individually or they may be used together:

- ✓ The first approach is a simplistic approach of comparing the results from each of the environmental themes calculated previously;
- ✓ The second is more complex and allows the effects calculated so far to be compared against the European totals for each of the environmental themes;

- ✓ The third approach allows for individual pollutants to be compared with the European pollutant emissions register.

The cross-media guidelines should be used with caution. One of the biggest concerns is the choice of multiplication factors, as these can skew the results significantly. Confidence in the calculated results diminishes as multiplication factors are used and different pollutants are aggregated. As each step introduces further uncertainty, the error bands surrounding the numbers accumulate.

Although the cross-media evaluation described here is comprehensive, it is neither exhaustive nor exclusive as there may be other additional factors that might be important in individual cases. There may for instance be pollutants released from the process that are not captured by the environmental themes described. There may be other pollutants that, although they have an effect within an environmental theme, there are no multiplication factors that have been derived for them. The Directive requires the consideration of issues that could not be incorporated in the assessment, such as noise, vibration, odour, risks to the environment, etc.

The user should be vigilant and ensure that any other important environmental effects that might occur as a result of applying a proposal are still considered in the assessment. Any issues not considered fully or any concerns about the validity of the data need to be understood both by the user of the cross-media methodology and the decision-maker. **Expert judgement** will be required in evaluating the results of the assessment and determining which option is preferred from an environmental point of view. The user will also need to ensure that transparency is always maintained throughout the assessment and in the decisions taken.

Once the options have been ranked according to environmental performance, the option that results in the lowest impact on the environment as a whole will usually be BAT, unless the economic considerations mean that it is not available.

15.2. The Costing Methodology

After the cross-media assessment, there may be a need to compare the costs of the alternative techniques. In order for the alternatives to be treated consistently, it is important that the cost information, which may have been derived from different sources, is collected and handled in the same way. The rules set out below help to set a framework under which the costs can be gathered, attributed and processed transparently, so that fair comparisons can be made /25/:

- ✓ When using cost data, it is important to remember that accounting conventions vary across Europe and between companies. As a consequence, it can be very difficult to make fair comparisons between cost information for installations, especially when those costs have been derived from different sources or have been manipulated in different ways.
- ✓ The costs should be broken down into a sufficient level of detail that shows which costs are attributed to investment expenditures and which are attributed to operating and maintenance costs.
- ✓ The choice of interest and discount rates need to be justified and those rates then applied in the same way to all the alternatives, so that they can all be compared fairly.

Applying these guidelines should allow both the user and the decision-maker to compare the alternative options in a transparent and equitable way. In practice, cost data are often estimated and seldom broken down into detailed components or to the level where changes in annual costs year by year can be made with any degree of accuracy.

There are many data sources from which cost data could be derived and the applicability, timeliness and validity of the data may differ depending on the source. Both the user and the decision-maker need to know about any concerns that could affect the validity of the data as they may have a bearing on the conclusions that are drawn from the assessment, and thus, on the final decision that is taken.

To help with comparison of the data, the cost components that have been included in the cost data should be clearly stated when the assessment is reported. The aim of the guideline should be to define which cost elements should be included or excluded, and also to give guidance on how those elements that are included should be reported. The breakdown of costs into its components, e.g. investment, operating and maintenance costs, etc., is essential for the transparency of the process, although it is often difficult in practice to split costs between process and environmental.

Once the cost information has been gathered, it needs to be processed, so that the alternative options under consideration can be compared equitably. There is often a need to be able to handle issues such as the different operational lifetimes of the alternatives, interest rates, the cost of loan repayments, the effects of inflation, and exchange rates. The user also needs to be able to make comparisons between costs that may have been derived at different times.

Some methodologies are set out below for processing and expressing the costs in such a way that fair comparisons can be made /25/.

- ✓ The most important issue when processing the costs is that the methodologies used and the steps involved are transparent. There is some flexibility, for instance, to apply different interest and exchange rates depending on the circumstances, but throughout this stage in the assessment, the user needs to justify the choices made and ensure transparency in all calculations used.
- ✓ Reported cost data should distinguish between those resources consumed by techniques that are implemented purely for the purpose of reducing or preventing emissions of pollutants, and those techniques that may be implemented for other reasons. These other reasons might include investment expenditure in energy conservation or waste minimisation technologies, which can yield commercial benefits that offset their costs. In some cases it can be useful to differentiate between those costs that are offset by commercial benefits and those that can be attributed to environmental protection.
- ✓ In general, end-of-pipe techniques tend to serve no other purpose than to reduce or prevent pollutant emissions. The entire investment expenditure for an end-of-pipe technique, including operating and maintenance costs can be regarded as environmental costs and can be attributed to environmental protection.
- ✓ In contrast, difficulties arise when assessing the environmental costs of process-integrated measures, as these affect the entire production process, and may serve other purposes in addition to pollution abatement. In this case, the entire resource cost cannot be attributed solely to environmental protection, as there are other benefits such as productivity improvements, or improved product quality. Where these benefits lead to savings that are greater than the cost of the environmental component, then the payback time of the measure should first be considered. If the payback time is less than three years, then the project is economically attractive to the operator and thus could be assumed, for the purposes of attributing costs, not to be primarily driven by environmental considerations.

15.3. Evaluating the Alternatives

After the environmental effects and the economic costs have been estimated for each of the alternative techniques, the alternatives need to be compared to determine which, if any, meet the criteria of BAT. The ultimate decision will rest with expert judgement, which can be assisted by the approaches described below. The cost effectiveness of a technique is crucial to the determination of BAT and, in this respect it is useful to find out which technique offers the most value (environmental benefits) for money (costs).

The most explicit way to compare costs and benefits of a measure is to monetarise both and compare them in a cost benefit analysis (CBA). When the comparison shows that the benefits outweigh the costs, this indicates that the measure represents a worthwhile investment. If different alternative measures give positive results, the measure with the highest result is the one offering the highest overall value for money. However, such a cost benefit analysis requires a lot of data and some benefits are difficult to monetarise.

Where there is a range of pollutants that will be abated by the implementation of a specific technique, there needs to be a way of apportioning the costs between the different pollutants that are abated. For example, catalytic converters reduce the emissions of NO_X, VOCs and CO. Therefore, this measure will not only reduce photochemical ozone creation effects (the primary reason for their introduction), but might also deliver reductions in eutrophication and acidification.

The assessment of the trade-offs that have to be made between environmental effects and the costs of the alternative techniques can be complex. Usually it is not possible to anticipate all of the possible eventualities and where there are weaknesses these have been pointed out. Although there is likely to be a need for some professional judgement when identifying the option that represents the best alternative, the methodologies should help the user make an objective judgement, as to how to balance costs and benefits. The methodologies also allow for the justification to be set out clearly and help to establish a transparent audit trail for any decisions that are taken.

Whilst the basic concept is an integral part of the determination of BAT, an in-depth assessment of ‘economic viability’ should not be carried out, unless there is genuine concern as to which environmental protection techniques can feasibly be implemented in the sector. There are no hard and fast rules that can be applied across the range and diversity of industrial sectors covered by the Directive and this analysis is therefore likely to be a difficult and time-consuming process.

In situations where ‘economic viability’ is identified as a critical issue, it should be considered in more depth in the determination of BAT. BAT often involves implementing a basket of techniques, which may not all require investment and which will often include management based techniques. Ultimately it is the overall costs of achieving BAT, possibly including both high cost and low cost elements, which affects economic viability of BAT. There may also be an opportunity to minimise the financial impact of implementation by defining longer time-scales for the introduction of high-cost techniques, so that implementation can coincide with routine plant and equipment rebuilds. Understanding the critical issues for the sector allows the decision-maker to determine the optimum combination of techniques that can deliver a high level of protection for the environment as a whole, without jeopardising ‘economic viability’.

16. HORIZONTAL GUIDANCE FOR RISK ASSESSMENT

16.1. The OPRA Methodology

Environmental Protection Operator Performance Risk Appraisal (EP OPRA) is a risk screening methodology that produces a risk assessment based on the following five attributes /18,23/:

1) Complexity - the type of activities covered by your permit/licence
2) Emissions - permitted releases into the environment (or into a facility)
3) Location - the status of the environment around your facility
4) Operator Performance - the management systems/procedures you have in place (Management Systems) and any enforcement action taken by certain bodies
5) Compliance Rating - how compliant you are with your permit/licence

Together these attributes will create an EP OPRA banded profile for the activity (-ies) covered by a Permit or Licence. Within each legislative regime, 'A' equates to the need for lower regulatory oversight and 'E' the need for more regulatory oversight. Each of the lettered bands can be converted to points to give an overall EP OPRA score. An EP OPRA score is required both to determine the risk posed by a facility and to set associated fees and charges for applications and subsistence /18/.

The first four attributes are used when an Operator applies for a Permit or Licence. A new fifth attribute, Compliance Rating, only becomes active after a Permit/Licence is issued. This will not be used to calculate application fees. It has been introduced to make it easier for operators to identify, how the compliance assessment systems link with EP OPRA. This change will give a more rigorous assessment of operator performance.

16.2. Complexity Attribute.

The more complex an installation, the more work will be needed to understand and check on:

- ✓ the processes involved,
- ✓ their interactions, and
- ✓ their pollution potential.

This attribute takes into account the following factors /23/:

- ✓ Activities carried out
- ✓ Potential for significant releases to one or more media.
- ✓ Use of one or several interconnected but distinct processes.
- ✓ Potential for accidental emissions.
- ✓ Inventory of potentially hazardous materials.
- ✓ Size relative to its sector and the other criteria mentioned here.
- ✓ Whether significant regulatory effort is required to assess and maintain compliance and to maintain public confidence.

16.3. Location Attribute.

The presence or absence of key receptors that could be affected by the activity is a further indication of the potential hazard of the installation and of the assessment required. This attribute takes into account the following factors /23/:

- ✓ Proximity of human habitation (domestic and industrial/office occupation, schools, hospitals, nursing homes, etc.).
- ✓ Proximity to sites designated under wildlife, countryside or habitats legislation.
- ✓ Whether or not the site is in a sensitive Groundwater Zone.
- ✓ Sensitivity of receiving waters.
- ✓ Potential for direct release to waters and the presence of control measures such as interceptors and balancing lagoons.
- ✓ Potential for flooding and the consequence of uncontrolled emissions to the flood-waters.
- ✓ Inclusion within an Air Quality Management Zone.

16.4. Emissions Attribute.

The substances that the activity may release into one or more environmental media will potentially impact the surrounding environment: the greater the release, the greater the potential impact. This attribute is generally based on the values in the Permit/Licence rather than on actual emissions. These are what are assessed during the permitting process and represent the maximum potential impact. Where emissions are difficult to quantify directly, they may instead, be represented by the types and quantities of materials being subject to a particular activity. The potential for emissions arising from unforeseen events and accidents is covered under the complexity attribute. The emissions attribute takes into account the following factors /23/:

- ✓ The type and quantity of substance in question;
- ✓ The media into which the release takes place e.g. air, land, water;
- ✓ The relative impact of that substance on that media

16.5. Operator Performance (Management Systems) Attribute

Operator performance consists of an assessment of the Operator's ability, preparedness and commitment to meet Permit/Licence conditions and other regulatory requirements. This takes into account the Management Systems in place (called OP1) and considers previous formal enforcement action taken by Regulatory bodies at the site (called OP2).

It is believed that effective Management Systems are important to managing the risk associated with an activity and to delivering Permit/Licence requirements. The Operator is responsible for managing an installation’s impacts and for ensuring compliance with Permit/Licence conditions. It is also believed that the absence of an effective and documented Environmental Management System (EMS) indicates a need for an increased level of regulatory oversight. The Management Systems in place and the regulatory enforcement history for the installation determine the Operator Performance (Management Systems) Attribute. This attribute takes into account the following factors /23/:

- ✓ Presence/absence of Management Systems or recognised procedures covering areas such as:
  - Operations and maintenance
  - Competence and training
  - Emergency planning
  - Auditing, monitoring, reporting and evaluation.
- ✓ Your enforcement history at the installation.

16.6. Compliance Rating Attribute.

This reflects the level of compliance with the conditions of the Permit/Licence (referred to as OP3). This attribute will be completed once the Permit/Licence has been issued and the compliance assessment activities begin. This attribute links to the Compliance Classification Scheme (CCS) and provides a rigorous assessment of the Operator's compliance with Permit/Licence conditions. In the future it may be replaced by some or all of the enforcement history elements (OP2), which currently are considered together with the Operator's Management System Attribute, and will be transfered to the new Compliance Rating Attribute. Compliance Rating will be based on CCS events.

This attribute takes into account the following factors /23/:

- ✓ Non-compliance with permit/licence requirements
- ✓ Potential impact on the environment as a result of non-compliance
- ✓ Additional compliance assessment effort required to deal with permit/licence breaches

16.7. Determination and review of EP OPRA banded profiles

EP OPRA banded profiles are set and reviewed at various stages during the regulatory cycle of application, determination (issue) and compliance assessment (permit/licence maintenance) /18/.

- ✓ **Application.** Use the information in your application to generate an assessment of the environmental risk associated with your activity. Complete/return the Excel spreadsheet with your application. You will be able to identify influences on your EP OPRA banded profiles (and, in conjunction with the charging scheme, the corresponding charge implications).
- ✓ **Determination.** When determining an application, the Regulator will review the information you give and your assessment of environmental risk. On the basis of this or additional information, the Regulator may change the score and banded profile. At the end of the determination process, the Regulator will review your environmental risk assessment score and EP OPRA profile based on the issued permit/licence. The Regulator will tell you about this when they issue the permit/licence.
- ✓ **Compliance assessment.** The Regulator will normally review the EP OPRA banded profile following action under their Enforcement and Prosecution Policy or as a result of compliance assessment activities, e.g. they become aware that you have lost your ISO 14001 certification or Eco-Management and Audit Scheme (EMAS) registration. Otherwise, it will be reviewed annually. In addition, the Regulator will assess your Compliance Rating Attribute (OP3) based on the previous year's compliance assessment findings recorded using CCS. You can request an amendment of your

banded profile at any time, but you will need to identify the changes that have occurred and explain why you want an amendment.

Transfer into PPC. For sites transferring to the PPC regime part way through a year the Compliance rating band will be awarded based on compliance information gathered throughout that year, i.e. this will include information from the previous regime, as well as information after the PPC Permit was issued.

16.8. Use of OPRA in Compliance Planning

The Regulator's compliance assessment work covers a wide range of activities, including those contained in the Recommendation of the European Parliament and Council (2001/331/EC) on minimum criteria for environmental inspections in Member States. This work includes:

- ✓ Carrying out site visits;
- ✓ Checking the processes and procedures in place to comply with permit/licence conditions and the law;
- ✓ Reviewing any self monitoring;
- ✓ Assessing operational activities;
- ✓ Checking premises and equipment (including whether it is maintained adequately) and the adequacy of environmental management at the site;
- ✓ Checking records;
- ✓ Monitoring the achievement of environmental quality standards.

Installations that are more complex with large quantities of emissions, in sensitive locations and/or with poor operator performance can expect to receive more compliance assessment activity.

The EP OPRA scoring system is structured around objective questions. The scores are then normalised and a banded output generated for the installation. A profile calculated by the OPerator or calculated by the Regulator, should be the same.

The Regulator expects that the scores and banded profile generated by EP OPRA will change with time, reflecting the changing environmental impact at the installation, and as the environmental performance improves or declines.

The detailed requirements for a particular management system are proportional to the risks the system seeks to manage. For all regulatory regimes, the presence of accredited certified management systems will be taken into account when determining risk profiles. Greater weight will be given to certified systems such as EMAS and ISO 14001, but other robust and auditable EMSs will be taken into account. These systems provide the Regulator with insight into the Operator's commitment to comply with the permit whether the Regulator is present or not /18/.

17. BENCHMARKS AND LIMITS IN PERMITS

17.1. Units for Benchmarks and the Setting of Limits in Permits

Releases can be expressed in terms of:

- ✓ "Concentration" (for example 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, but total flow must be measured/controlled as well.
- ✓ "Specific mass release" (for example, g/kg product, g/MJ, or other appropriate parameter), which is a measure of the overall environmental performance of the plant (including the abatement plant) compared with similar plants elsewhere.
- ✓ "Absolute mass release" (for example, kg/hr, t/yr), which relates directly to environmental impact.

Table 6 shows quantitative benchmarking parameters applicable in the FDM sector.

Table 6: Benchmarking parameters /26/

Performance indicator	Benchmarking parameter
Air emissions	Mass of emission per unit of production or per unit af raw material used
Waste water	Volume of water, mass of contaminants, or BOD/COD per unit of production or per unit of raw material used
Solid waste	Mass of waste per unit of production or per unit of raw material used
Energy resources	Energy use per unit of production or per unit of raw material used
Utilities and services	Use of water, compressed air or steam per unit of production or per unit of raw material used
Other	Consumption of specif materials, e.g. packaging, per unit of production

Data on emissions to air and water are available for some sectors and also for some processes within installations, but the latter are scarce. In the future more detailed information may be available, when this is reported to EC's European Pollutant Emission Register (EPER). This is a requirement under Commission Decision 2000/479/EC. For FDM acitivities under Annex 1, paragraph 4 of the IPPC Directive, six air pollutants (methane, carbon monoxide, carbon dioxide, HFCs, ammonia and NOx) and four water pollutants (total nitrogen, total phosphorous, TOC and chlorides) are listed.

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 which 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 substituting parameters that reflect optimum environmental performance of the plant as the routine measurement, supported by less frequent check-analyses on the final concentration. Examples of surrogate measures would be the continuous measurement of conductivity (after ion-exchange treatment) or total carbon (before a guard-column in activated carbon treatment) to indicate when regeneration or replacement is required.

The emission level limits should be based on average values, not on maximum, short-term peak values, which are generally higher. The emission levels should be set at a typical averaging period of i.e. not less than 30 minutes and not greater than 24 hours /6, 24/.

For some installations the emission limits, monitoring frequencies, averaging times and compliance assessment criteria are specified in the relevant EC Directives. The Directives also require CEN standards for monitoring to be used, where available. The specific requirements of the Waste Incineration Directives are given as an example in Annex 3.

17.2. Statistical Basis for Benchmarks and Limits in Permits

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

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

Where no limit values for emissions have been regulated by the law, the Regulator can set the limits according to sector-specific BAT-values, but normally these should only be used as indicative requirements and as benchmarks for acceptable performance.

Based on a survey done with 57 Nordic dairies the following benchmark values for BAT on water and energy use and water loads can e.g. be used.

Table 7: Indicative consumption and emission limits for dairies /29/.

Product portfolio	Energy Consumption KWh/litre of received milk	Water consumption Litres/litre of received milk	Wastewater discharge Litres/litre of received milk
Market milk	0,1 – 0,2	1,0 – 1,5	0,9 – 1,4
Cheese	0,2 – 0,3	1,4 – 2,0	1,2 – 1,8
Powders	0,3 – 0,4	0,8 – 1,7	0,8 – 1,5
Ice cream (per kg of product)	0,8 – 1,2	4,0 – 5,0	2,7 – 4,0

Similar types of benchmark values can also be found for many other industrial sectors.

Within the FDM sector most common benchmarks compare utilities' consumption against production, and, therefore, give a good indication of the efficiency and also of wastage occurring within the process. This is also called quantitative benchmarking. The percentage of raw materials gowing to the final main products is variable and waste minimization is generally considered as a cost effective goal for all manufacturers, but benchmarks are not readily available. The percentage of wastage can vary from 1% in dairies to 80% in potato starch production /29/.

18. FINNISH EXPERIENCES OF BAT ASSESSMENT AND IPPC PERMITS

In the following a few examples of IPPC Permits issued to Finnish FDM plants are presented. Special attention is paid to BAT issues and permit conditions. A few case studies on dairies, were furthermore presented at a separate workshop held in Vilnius, Lithuania in June 2006 /30/.

18.1. A Food Processing Plant

The plant produces fresh ready-to-eat food dishes, pre-cooked and semi-frozen micro-oven products, and also deep-frozen food products from meat, fish, potatoes, rice, pasta, vegetables, and other ingredients. The main products are different types of loafs, stews, meat products, soups, broiler products, fish products, pasta and vegetable dishes.

The food processing plant is located on a 45 ha big site. In addition to the processing plant the company has its own slaughterhouse and chicken breeding plant. The broilers are raised on contract farms nearby, but are slaughtered and pre-processed on the site. Close to the site is a public wastewater treatment unit and the plant has its own laboratory, personell restaurant, product development unit, factory shop, transport and storage unit, and a washing-unit for recycled plastic transport boxes. The cooling and heating stations on the factory site are owned by an external energy producer. Annually the food processing plants on the site use about 400 000 m^3 of water and the operation is protected by an enviromental insurance.

The raw materials are mainly brought in to the plant pre-processed. Roughly 3 000 t/a or 50 % of the potatoes are peeled on-site. In the backyard there are 40 - 60 m^3 large storage tanks for rice, vegetable oil and syrup. The main processing steps for fresh food products are materials reception and preparation, size-reduction, mixing and forming, cooking, frying, cooling and packaging. There are separate processing lines for different types of food products. The products are packed in alumina, plastic or cardboard boxes, and are delivered to customers on plastic trays that are recycled and re-used after washing and disinfection. The production is normally based on 3 x 8 hours' shifts and the cleaning is carried out during the night shift. The pre-processing units are electricity-driven and the ovens oil-, gas- or electricity driven.

The production capacity is presently 120 t/day or about 30 000 t/a. The maximum planned production capacity of the processing plant is 35 000 t/a, but reaching this capacity would require an extension of the factory and some process modifications. The unit for peeling of potatoes uses about 30 m^3 of water/day and the processing plant about 1 000 - 1 500 m^3/day. The cooling water system of the plant is a closed-circuit system.

As a result of the energy efficiency assessment of the plant, done by Vattenfall Ltd, a heat recovery system in the cooling station has been taken into use. Roughly 7 000 MWh/a heat is recovered and used for heating of water used in the process. In total the processing plant uses 26 000 MWh/a electricity, 28 000 MWh/a steam and 3 000 MWh/a LPG. According to future plans LPG will be changed to natural gas and natural gas will also replace a part of the electric energy used in the process.

In the Permit Application the Operator classifies the minimisation of ammonia emissions, the wastewater treatment system, and the blood recovery system of the slaughterhouse as BAT.

According to the Permit issued by the local Regulator, the Operator is obliged to prevent any feathers, oil, grease, detergents, and any other material that may disturb the function of the wastewater treatment system from intruding into the plant. The Regulator has also requested the Operator to minimize all risks connected to the use of ammonia on the site.

In a reply to the Regulator the Operator has clarified that detergents and disinfectants are chosen according to the principles of minimal environmental impacts. The wastewater from the slaughterhouse passes through a mechanical sieve, whereby feathers are removed. Possible oil spills from the heating station are recovered in a dwell and a tank. All bigger amounts of grease and oil from the process are recovered and reused, and hence the amount of oil and grease in the wastewater is minimized. A stricter control of all detrimental components in the wastewater has been taken into use.

In the Permit the Operator is requested to monitor the noise emissions from the production plants and the slaughterhouse by using an external expert. In the monitoring report a spreading model for noise should be included and in the impact assessment possible impulses, low frequencies, and narrowness of noise emissions should be taken into account.

In the granted Permit the Operator is furthermore obliged to lead all wastewater from the plant to the public wasterwater treatment plant, and is requested to keep the loads as small as possible. If the set limit values are broken the Operator must study the reasons for this and must undertake corrective measures.

The Operator must be aware of any negative effects of detergents and disinfectants used in the process (Permit Conditions 1 & 2). All solid wastes from the plant must be treated according to the Waste Act and the Operator should try to prevent the generation of wastes. The Operator should stop the use of its own landfill site immediately (Permit Conditions 9 & 10).

The Operator is furthermore requested to arrange for continuous monitoring of the performance of the plant, and of the quantity and quality of wastewaters and solid wastes. The monitoring programme shoud be approven beforehand by the Regulator. A monitoring report should be sent to the Regulator annually. In the report the following issues should be covered:

- ✓ Production, raw materials and time of operation;
- ✓ Amounts and quality of fuels and chemicals used;
- ✓ Wastewaters;
- ✓ Process disturbances that have increased emissions;
- ✓ Summary of corrective measures;
- ✓ Monitoring reports;
- ✓ Planned changes of the plant or of operational performance;
- ✓ Summary of wastes, their quantity and quality, storage, transport, and treatment;

All documents, such as analytical protocols, flue gas control and other measurements have to be kept in store for at least 3 years.

The Operator is obliged to assess the application of BAT for the reduction of water use and for the reduction of the amount of grease in the wastewater. The grease makes the composting of the wastewater sludge difficult (Permit Condition Nr 4).

No littering from the broiler farms is permitted (Permit Condition Nr 5).

The Waste Act defines the circumstances under which the waste can be submitted. According to the Act the waste can only be handed over to a registered driver or to a person, who has a license to receive waste according to the environmental permit in the Environmental Act (Permit Condition Nr 6).

The storage of raw materials, chemicals, fuels, and wastes should not cause any health risk or environmental harm. Rain water should be taken care of so that it does not interfer with the above mentioned hazardous materials (Permit Conditions 3, 7, 11 & 12)

The Operator must be reasonably well aware of all environmental impacts from operational performance and of ways to minimize any negative impacts. Limits for noise emissions can not be exceeded and noise levels in the surrounding should be monitored (Permit Conditions 13 & 14).

A plan for monitoring and control of all operational activities and impacts should be made and followed. A record of emissions and wastes should be kept and updated continuously (Permit Conditions 19 – 22).

18.2. A Vegetable and Berry Processing Plant

The plant produces deep frozen vegetables, jams and marmalades of different market brands. The capacity of the vegetable processing plant is 30 000 t/a and the raw materials are mainly grown by contract farmers that operate on nearby fields, according to instructions provided by the company. Daily the plant can receive 100 – 350 t/d of vegetables. Mostly are carrots, beans and potatoes used. The reception and pretreatment operate in three shifts from june to december, and the deep-frozen raw ingredients are being processed in two shifts around the year. The cooling plant uses ammonia and liquid nitrogene as cooling media.

The production capacity of the berry processing plant is 6 000 t/a.

The use of energy is considered to be the most important issue from environmental impact point of view. The energy use is monitored on a weekly basis and precise objectives have been set on a yearly basis. The goal is to continuously inprove the energy efficiency of the plants. The total energy use in 2002 was 10 300 MWh electricity, 8 400 MWh steam and 4 100 MWh of other heat forms. In 2001 and 2002 the energy efficiency was improved by pre-heating the incoming air to the berry plant, by decreasing heat losses through the door to the raw material storage, and by changing the heating and air conditioning systems.

In the Environmental Permit granted to the plant it is requested that:

- ✓ All wastewater (excluding cooling water) must be treated at the plants' own wastewater teatment facility according to a separate agreement .
- ✓ The amount of wastewater should be minimised according to BAT principles when modifying or renewing processes and/or equipment.
- ✓ Wastes should be reused as raw materials or for energy production, and must be treated in accordance with what the Waste Act stipulates.
- ✓ Hazardous wastes must be stored under roof and in a locked space, and the same waste fraction cannot be stored for a period longer than one year. When delivered to licensed hazardous waste treatment facilities it should be packed in containers that are properly sealed and marked.
- ✓ Composting of sludges from wastewater treatment and vegetable processing must be taken care of in such a way that odorous emissions and other environmental impacts are minimised. There should be enough oxygen, moisture and nutrients in the compost, and the pH-value should be kept at a level suitable for stable microbial activity, so that the temperature rises to a level high enough for the compost mass to become hygiene.

The compost piles should be mixed intermittently and if necessary covered with a layer that absorbs the smell.

- ✓ The technique for wastewater sludge treatment should be improved. A techno-economic assessment of alternative BAT techniques must be presented to the local environmental authorities.
- ✓ Only ordinary waste that can not be recycled or reused at the processing plant can be disposed of at the companys own waste dump. The site can only be used until 31.10.2007 unless it is improved according to landfill site regulations. Continuous monitoring and control of the dumping site must be maintained.
- ✓ Maximum limit values for the noise level in the compressor room of the freezing plant and for the fan in the boiler room have been set, and when modifying or renewing equipment BAT techniques should be taken into use.
- ✓ Energy saving possibilities should be assessed annually and energy efficiency improved continuously and systematically. Achieved improvements should be reported. The next energy audit should be done until the end of year 2008.
- ✓ An assessment of risks to the groundwater from the composting site and the waste dump should be done by an external expert organisation. A complete risk assessment and necessary improvements to prevent any negative impacts should be presented to the authorities by the end of year 2005. The risk assessment should also cover the wastewater treatment plant.
- ✓ A deposit of 50 000 euros as insurance for the operation of the waste treatment facility is required.
- ✓ Accidental or abnormal emissions must be reported immediately and must be documented in writing.
- ✓ The most significant sources of noise must be monitored at least thrice annually and always when any changes are undertaken.
- ✓ A waste register must be kept and presented to the local authorities annually.
- ✓ A report with data on production and raw materials, emissions to air, amount and quality of wastewater and all solid wastes; on waste treatment, storage and transport; on the control and monitoring of noise; a summary of emission monitoring data and an expert judgement of operational impacts; data on emissions and wastes caused by accidents and/or abnormal situations; information on investments and actions towards improved environmental performance and better energy efficiency, and any process changes implemented or planned during the year should be reported to the authorities anually.
- ✓ The Operator should take part in regional assessments and monitoring of air and water quality, noise and odourous emissions.

18.3. A Fruit Juice Processing Plant

The plant produces pasteurised and aseptically packed fruit juices and berry soups and also small amounts of milk products. Some of the products are warm and some cold, and some so called functional products. The total annual production capacity is 51 000 t/a, but it can be increased up to 95 000 t/a. All juice products are produced batch-wise. The amount of board packages used for beverages is 1 630 t/a and that of plastic packages ~100 t/a.

The storage functions as a local product store and as a national store for the company's less frequently distributed products. Annually roughly 210 000 tons of products are handled in the storage facility.

The juice plant operates in two shifts 5 days a week and the storage operates in three shifts 6 days a week. 70 persons work in the process plant and 180 persons in the storage. 25 persons work at the office.

The plant uses roughly 10 000 t/a of raw materials and 43 000 m^3/a of water. A part of the water used passes through AC-filters before use and 90 % of the water is recycled. Annually roughly 6 000 – 25 000 m^3/a of water is lost when cooling the products. The indirect cooling system used is considered as BAT and is based on the use of ice water and Freezium (Potassium formiate). Condensing heat is recovered and all electrical pumps, mixers, conveyors, and packaging machines are equipped with frequency inverters?

In the years 2000 – 2002 the use of heat and electricity was the following:

Energy use	**2000**	**2001**	**2002**
Heat (GJ/ton of juice)	1,01	0,95	0,89
Electricity (GJ/ton of product) in the juice factory	0,35	0,34	0,31
Electricity (GJ/ton of product) in storing	0,11	0,10	0,10

8 of the cars distributing cold products use CO_2-cooling instead of diesel fuel driven compressors.

In the companys environmenatal management system set goals are the reduction of the amount of wastes and wastewater produced. The set target (20 %) for solid waste reduction was achieved and exceeded by far (68 %) already after two years through improved source separation and recycling. The set target for wastewater reduction (10 %) was also reached within 2 years through better recovery of products and raw materials, when starting-up and shutting-down the production process. Recycling of rinsing water and automatic dosing of chemicals have also reduced the amount of wastewater. The production plant has also signed an energy saving agreement with the Ministry of Trade and Industry and improvement options have been sought through systematic energy audits.

The Regulator has set the following conditions in the Permit:

- ✓ All wastewaters led to the sewage system must fulfill the requirements set in the agreement between the plant and the local water board. The amounts of solids, nutrients and grease in the wastewater should be minimised. The Operator should be aware of any detrimental effects caused by the use of chemicals in the plant.
- ✓ Noise levels caused by the Operator in nearby residential areas should be below 55 dB during daytime and below 50 dB during the night.
- ✓ All solid wastes from production should be source-separated and stored properly. The amount of wastes should be minimised. Only wastes that cannot be recycled, re-used or used for energy purposes can be landfilled, unless they contain hazardous components.
- ✓ Raw materials, chemicals and wastes must be properly stored on the site, so that they do not cause any harm to the soil, surface- or ground water, or to the environment.

- ✓ Any accidental or abnormal situation that causes emissions must be reported to the local environmental authority and the Operator must immediately take actions by which the emissions and similar situations can be prevented.
- ✓ A risk assessment should be continually updated and done annually. Special attention should be paid to possible ammonia lekages.
- ✓ The Operator should monitor and control emissions and wastewaters and present a report annually.
- ✓ A report with all relevant production data should be produced annually and if possible documented electronically directly on a web site maintained by the environmental authority.

18.4. A Milk Processing Plant

The plant processes 350 000 – 400 000 lites of milk daily. The milk products are heat-treated and packed. The main products are pasteurised milk, cream and sour milk. In addition some milk-based half-fabricates are produced for other food producers. The total production in 2001 was 71 500 tons and in 2003 90 700 tons. Since the shutdown of the company's plant in another city the production has increased to roughly 120 000 t/a. A certified EMS has been in use since year 2000.

When the company's dairy in the other city was shut down 75 % of the milk processing was transferred to the other plant. Hereby transport distances increased by 35%, the use of steam and energy by 25%, the amount of wastewater by 10%, and the wastewater load by 5%.

Due to the nature of the raw materials used machines and other equipment must be washed frequently and the hygiene requirements are high. The plant generates wastewaters with high organic load that are treated at a plant nearby. The amount and quality is monitored daily. The pH-value of the wastewater varies between 2 and 12 and the reasons for this is not quite clear. The COD-load from the plant is on average 1,2 – 1,3 tons/d and 3 000 – 4 000 litres of whey from cheese production are daily lead to the sewers. According to the company's EMS the goals are to reduce the amount of wastewater and its COD-load, and to stabilise the pH-value of the wastewater.

A large amount of different types of packages are used and the amount of packaging waste is significant. In addition to packaging waste different types of liquid product wastes are generated. Milk and acid sludges from the wastewater treatment are recovered for use as fodder.

Much energy is used for heating and cooling purposes. The cooling system operates mainly on ammonia. Natural gas is mainly used for the production of heat and steam. Heavy fuel oil is used as a substitute fuel source. In 2003 the energy use was 0,15 MW/ton of product. In the energy audit done in 1995 the following energy saving measures were identified and later implemented:

- ✓ Better insulation of the sidewalls and the manholes of the wastewater tanks;
- ✓ Better control of the temperature of ventilation and heating equipment;
- ✓ Improved condensing efficiency of cooling equipment;
- ✓ Recovery of heat from secondary water with the aid of heat exchangers;
- ✓ Recovery of heat from the ventilated air.

In 2001 in total 6 130 MWh electricity was purchased. The biggest electricity user was the cooling plant. Almost 14 000 MWh steam was used for heat treatment of products and for heating of washing liquors. The biggest users of heat were the pasteurisation equipment.

The heat-exchange system used for product heating and cooling is considered as BAT. Condensed heat is also used for heating of the plant and for rinsing purposes. Cooling water is recycled for external washing of equipment and of cars.

In controlling the production processes an optic system is used for steering the solid-liquid products in the pipes. When rinsing the pipes conductivity measuring devices are furthermore used for better control and recycling of chemicals.

Nitric acid and sodium hydroxide is used as washing chemicals. In total 780 m^3/d of rinsing water circulates through the pipes and 630 m^3/d is recycled. The washing liquids are totally changed once or twice a year, whereby the rinsing water tanks also are cleaned, but the rinsing water is partly renewed on average every second week.

All solid wastes are separated and partly recycled. The amount of disposable solid wastes has decreased steadily.

In the Permit granted to the Operator the following conditions have been set among others:

- ✓ The amount and load of wastewaters should be kept as low as possible, by i.a. preventing raw materials, products or wastes from the sewers.
- ✓ The Operator must be aware of how the rinsing agents and chemicals in use affect the wastewater treatment process and the environment. Wastewater led through the sewer to the public wastewater treatment plant must not disturb its operation or functioning.
- ✓ The pH-value of the wastewater has to be between 6,0 – 11,0, with the exception of short and non-significant deviations. A plan for neutralising the wastewaters should be presented to the local environmental authorities not later than 2 months before planned implementation. A report with monitoring results from a two-month period 6 months after implementation should be sent to the Regulator.
- ✓ The Operator should present a techno-economic assessment of whey recovery and its utilisation possibilities. In addition to this the Operator should clarify the points where raw milk and milk products can intrude into the sewer system.
- ✓ Rain and surface waters must be taken properly care of.
- ✓ No noise impact from the operation of the plant is accepted. The noise level in the residential area close to the plant may not exceed 55 dB in daytime and 50 dB during the night.
- ✓ The generation of waste should be minimised and the recyclable waste should be collected and sorted. If other use modes are possible the waste should not be incinerated.
- ✓ A competent person responsible for the waste treatment site should be nominated.
- ✓ Hazardous wastes should be stored in sealed and marked containers under roof in a place with no sewers and so that possible liquid spill-over can be collected.
- ✓ The storage and use of chemicals, raw materials, and wastes may not cause any environmental or esthetic harm to the soil, surface- or ground water, nor negative impacts on the sewer system.

- ✓ The Operator should be reasonably well aware of the development of BAT within its own sector of operation and should be prepared to implement such techniques. When renewing processes and/or purchasing new euipment, BAT should be applied in such a way, that the plant's emissions, energy use, and environmental impacts are as small as possible.

18.5. A Brewery

The brewery produces beer, cider, other low-alcoholic drinks, soft drinks, mineral water, and energy and other special or so called functional drinks. The personell is close to 900. Roughly 400 work with production, 250 in the transport unit, and the rest with administration, marketing, research, product development, and quality control. Normally the plant operates in three shifts, but not during weekends. During peak periods – usually in the summer – the plant operates 7 days/week. Distribution and transport of products takes place around the clock. The plant purchases its energy in the form of electricity and hot water from an adjacent power plant that operates on natural gas.

The total production is 360 million litres/a and according to statistics from year 2002 the production generates as a side product 11 000 t/a of mash (with 30% dry solids content) and 700 t/a of yeast (20% DS). Beer and cider production is 180 million l/a, but can be raised to 280 million l/a. The corresponding numbers for soft drinks are 205 million l/a and 235 million l/a. Filling and storage has been designed for max. 350 million l/a and the maximum continuous production is 454 million l/a. The nominal transport capacity is 400 million l/a and the maximum 525 million l/a. Mash recovery has been designed at max. 11 000 t/a and that of yeast at max. 1 100 t/a.

The production of wort is a batch cooking process. The malt is crushed in a hammer mill, mixed with water and transferred to the mash kettel, where the temperature is raised step by step. The starch of the malt hereby converts to sugars. After cooking the mash is filtrated and the wort is pumped to a kettel to which hobs are added. The cooked and hot wort is then clarified in separation tanks. The mash and trub that are separated in filtration and clarification are transferred to a silo before being sent to fodder production. The hot wort is cooled with cold water in heat exchangers and then pumped to fermentation vessels. Yeast is added to the wort and it is being aerated in order to speed up the fermentation. After fermentation the semi-products are rapening in tanks or reactors before filtration. After filtration the beer is transferred to pressurised containers before being bottled or distributed in tank lorries. The extra yeast that is separated from the beer during fermentation and filtration, the kieselguhr sludge, and the used filter plates are sent to fodder production, composting or soil conditioning.

The main process steps in the production of soft drinks are the production of the basic juice, mixing, and carbonisation of the ready products. No side products are generated in soft drinks production and the production is batch-wise. The basic juices are stored in intermediate tanks before water and carbon dioxide is added and they are finally filled into bottles or other drink packages.

The environmental impact from the plant is mainly connected to the production process and transport. In addition to raw materials the brewery uses energy, water, cleaning agents and other chemicals. The energy use is, however, modest and no hazardous or significant odorous emissions to the environment occur under normal performance conditions. No soil contamination has ever been observed.

Process wastewater is generated from the washing and rinsing of equipment, containers, bottles, boxes and pallets. They contain some raw materials, rest products, acid and basic washing and disinfection agents, and steam condensates. The amount of wastewater from the cooling plant is roughly 3 000 m^3/d and according to analyses results of 2002 its quality was the following:

Table 9: Data on wastewater from the brewery /35/

Parameter	Average value
Quantity	860 000 m^3/a; 2 360 m^3/d
BOD_7	1 900 mg/l; 4 484 kg/d
COD_{Cr}	3 100 mg/l; 7 316 kg/d
Dry solids content	220 mg/l; 520 kg/d
Phosphorous	26 mg/l; 61 kg/d
Nitrogen	42 mg/l; 99 kg/d
pH	7,4

The wastewater is pumped to a stabilisation tank and if necessary it is neutralised. The pH-value is monitored continuously both for the incoming and the outgoing wastewater. On average 24 m^3/a of sludges is formed in the sedimentation tank.

The company has benchmarked its production process against BAT values given in EU's draft BREF Document for the FDM sector /26/ and against performance indicator values given in the Guidance Notes for establishing BAT in the brewing industry, issued by CMBC, The Brewers of Europe. The following table gives an overview of the BAT assessment done at the plant:

Table 10: Performance indicators and BAT values for a brewery /CMBC/

Performance Indicator	Unit	CBMC Recommendation	The Plant
Use of heat energy	MJ/100 l	100 - 200	54
Electricity consumption	KWh/100l	8 - 12	8,7
Water consumption	100l/100l	4 - 10	3,2
Amount of wastewater	100l/100l	2,2 – 8,7	2,4
Wastewater load	COD/100l	0,8 – 2,5	0,74
Solid wastes	kg/100l	<1 – 20*	0,15
Malt usage	kg/100l	10 – 20**	9,5

*) upper limit value for beweries that can not reuse any sideproducts

**) depends on how strong the beer is

All values in the above table show that the performance of the plant can be considered to be BAT from all assessed indicator points of view. In addition to these indicators the Operator has also assessed the possibilities of CO_2-recovery, the quantity of which is 3 500 t/a. CO_2-emissions to the air have been estimated at 11 500 t/a and could thus theoretically easily cover the total needs, which are 8 000 t/a. Presently the plant's CO_2-need in the production proess is, however, taken as a side product from hydrogen production.

With the aim of reducing the energy use at the plant the following measures have been taken:

- ✓ Heat is recovered in the form of hot water from the vapours from the wort boiler and from cooling of the wort. The heat is used for mashing and washing.
- ✓ All equipment and pipes are insulated.
- ✓ Direct ammonia is used for cooling of the fermentation vessels.
- ✓ The operation of the cooling plant and of the compressors in the air compression plant is steered by an automatic process control system.
- ✓ The incoming air is warmed up by the outgoing air in the air conditioning system.

The following water conservation and wastewater reduction measures have been implemented:

- ✓ All final rinsing waters are recovered and all rinsing units operate with recycled water.
- ✓ No tunnel pasteurisers are used.
- ✓ The trub from clarification of the wort is recovered.
- ✓ Surplus yeast, final wort and beer residues are recovered.

The following waste minimisation measures have been implemented:

- ✓ By centrifuging the beer before filtration of the kieselguhr sludge the amount of sludges are kept as small as possible.
- ✓ Most packaging materials used are recyclable.
- ✓ Raw materials and other goods are purchased in large quantities and the packaging material is recycled if possible.

In order to reduce noise impacts, all bottles, vessels and bottle boxes are handled inside the buildings and the filling unit has been equipped with noise traps.

In order to reduce odorous emissions the steam from cooking of the wort is condensated, whereby odour causing components are transferred into the wastewater.

The plant has a certified ISO 14 001 EMS since March 2003.

When the Operator applied for a Permit the authorities paid attention to especially the following issues:

- ✓ The quantity and quality of wastewaters and the handling of sludges
- ✓ The possible risks of ammonia emissions, and
- ✓ Odour and noise

The limit for daily organic load to the public wastewater treatment plant has been set at 9 000 kg/d. The Operator was requested to make a complete risk assessment of ammonia emissions including a spreading model and a plan for preventative measures. In order to reduce odorous emissions the Operator was asked to survey the possibilities of moving the steam condensers of the wort kettels inside the building. It was furthermore recommended that the plant should stick to BAT whenever possible and feasible.

19. REFERENCES

1. Anttalainen, M. 2006. ***"The Environmental Legislation in Finland"***. Paper presented at a Workshop on BAT and IPPC Implementation in Lithuanian FDM industry; June 2006. Vilnius, Lithuania.
2. Anttalainen, M. 2006. ***"Monitoring of Environmental Permits in Finland"***. Paper presented at a Workshop on BAT and IPPC Implementation in Lithuanian FDM industry; June 2006. Vilnius, Lithuania.
3. Department of the Environment; Environment Agency, UK. 1995. ***"The Categorisation of Volatile Organic Compounds"****;* DOE Report*; 71 pp.*
4. Department for Environment, Food and Rural Affairs; UK. 2004. "***Integrated Pollution Prevention and Control (IPPC) - A Practical Guide",*** *Edition 3; London, UK; 127 pp*
5. Environment Agency, UK. 2000; "***Integrated Pollution Prevention and Control*; *Form IPPC 1 – Application for a Permit***; 161 pp.
6. Environment Agency, UK. 2001. "***Integrated Pollution Prevention and Control (IPPC) - Guide for Applicants"***;
7. Environment Agency, UK. 2001. "***General Guidance for the Dairy and Milk Processing Sector***"; 145 pp.
8. Environment Agency, UK. 2001.***"Guidance for the Food and Drink Sector - IPPC Sector Guidance Note"***; 143 pp.
9. Environment Agency, UK. 2001. ***"Integrated Pollution Prevention and Control*; *Part A(1) Installations: Pig and Poultry Rearing Units; IPPC Application Form – Guide for Applicants***; 50 pp.
10. Environment Agency, UK. 2002. ***"Integrated Pollution Prevention and Control (IPPC); Energy Efficiency - Horizontal Guidance Note"***; 46 pp.
11. Environment Agency, UK. 2002. ***"Technical Guidance Note: Monitoring of Stack Emissions to Air"***; 72 pp.
12. Environment Agency, UK. 2002. ***"Technical Guidance Note: Sampling Requirements for Monitoring Stack Emissions to Air from Industrial Installations"***; 38 pp.
13. Environment Agency UK. 2002. "***Integrated Pollution Prevention and Control (IPPC) - Horizontal Guidance for Noice. Part 1 – Regulation and Permitting***"; 38 pp.
14. Environment Agency, UK. 2002. ***"Integrated Pollution Prevention and Control (IPPC); Horizontal Guidance for Noice. Part 2 – Noise Assessment and Control***; 89 pp.
15. Environment Agency, UK. 2003. ***"Guidance for the Red Meat (Cattle, Sheep and Pigs) Processing Sector - IPPC Sector Guidance Note"***; October 2003; 109 pp.
16. Environment Agency, UK. 2003. ***"Guidance for the Poultry Processing Sector - IPPC Sector Guidance Note"***; 105 pp.
17. Environment Agency, UK. 2003*.* ***"Assessment of Monitoring Arrangements for Emissions to Air"****; Draft Report; 12 pp.*

18. Environment Agency, UK. 2003. ***"Environmental Protection Operator and Pollution Risk Appraisal (EP OPRA); Risk Screening Methodology for the Pollution Prevention and Control Regulations – User Guide***", Version 2; 20 pp.

19. Environment Agency, UK. 2004. ***"Integrated Pollution Prevention and Control (IPPC) - Horizontal Guidance for Odour. Part 1 – Regulation and Permitting"***; Technical Guidance Note; 78 pp.

20. Environment Agency, UK. 2004. **"*Integrated Pollution Prevention and Control (IPPC); Horizontal Guidance for Odour. Part 2 – Assessment and Control"***; *Technical Guidance Note;* 85 pp.

21. Environment Agency, UK. 2005. **"*Guidance on Producing a Good PPC Application"***;

22. Environment Agency, UK. 2005. ***"Environmental Protection Operator and Pollution Risk Appraisal (EP OPRA)"***; Version 3; 137 pp.

23. European Commission. 2001. ***"Integrated Pollution Prevention and Control - Reference Document on Best Available Techniques to Industrial Cooling Systems"****; 335 pp.*

24. European Commission. 2003. **"*Integrated Pollution Prevention and Control (IPPC); Reference Document on the General Principles of Monitoring"*;**

25. European Commission. 2006. ***"Integrated Pollution Prevention and Control; Reference Document on Economics and Cross-Media Effects***"; 175 pp.

26. European Commission. 2006. ***"Integrated Pollution Prevention and Control (IPPC) – Reference Document on Best Available Techniques in the Food, Drink and Milk Industries***"; 682 pp.

27. Finnish Ministry of the Environment. 2004. **"*Ympäristölupahakemuksen laatiminen (Guidance on Permit Application)"****;* 22 pp.

28. Lounais-Suomen Ympäristökeskus; 2005. ***"Ympäristölupapäätös" ("Environmental Permit")*** Nr LOS-2003-Y-1297-111; 17 pp.

29. Nordic Council of Ministers. 2001. **"*Best Available Techniques (BAT) for the Nordic Daiy Industry***"; 140 pp.

30. Pankakoski, M.*;* 2006. ***"Case Examples from Finland – BAT in Dairy Industry and Co-operation with Authorities"****;* Paper presented at Workshop on IPPC & BAT in Lithuanian Food, Drink and Milk Industry; Vilnius, Lithuania; June 2006

31. Pirkanmaan Ympäristökeskus. 2003. ***"Ympäristölupapäätös" ("Environmental Permit")*** Nr PIR-2001-Y-1291-111; 22 pp.

32. Pirkanmaan Ympäristökeskus. 2004. ***"Ympäristölupapäätös" ("Environmental Permit")*** Nr PIR-2003-Y-4-111; 30 pp.

33. Scottish EPA; 2000. ***"The Pollution Prevention and Control (Scotland) Regulations 2000 - A Practical Guide (Part A Activities)***"; 96 pp.

34. Scottish Environment Protection Agency. 2000. ***"Integrated Pollution Prevention and Control; Part A Installations – Guide for Applicants"***; 28 pp.

35. Uudenmaan Ympäristökeskus. 2004. ***"Ympäristölupapäätös" ("Environmental Permit")*** *Nr 0101Y0164-111*; 32 pp.

36. Uudenmaan Ympäristökeskus; 2005. ***"Ympäristölupapäätös" ("Environmental Permit")*** Nr 0101Y0206-111; 28 pp.

20. APPENDICES

Appendix 1: Examples of Explanatory Notes

Choosing the Right Technical Guidance /22/

You will need to consider which Technical Guidance is the most applicable in the light of your activities. It is vital that you use the most appropriate guidance since this will dictate the standards against which your proposals will be compared. We strongly recommend that you speak to us to find out what is the latest and most appropriate guidance available.

The relevant Technical Guidance note for your sector will either be:

- ✓ the specific ***PPC PART A or IPPC Technical Guidance Note for your sector*** where one exists (in some cases the Environment Agency or SEPA has produced interim guidance in advance of full sector guidance being available); OR, where such PPC PART A guidance has yet to be produced for your sector:
- ✓ the ***IPPC Common Technical Guidance Note*** which covers the relevant issues under Part A PPC or IPPC that were not dealt with by the previous regulatory regimes of IPC and Waste Management Licensing. This note should be used in conjunction with the appropriate existing IPC guidance or waste management papers.

Either of these Technical Guidance Notes will lead you through this part of your application. The following explanation puts the Technical Guidance and the methodology used into context.

The choice between the ***PPC PART A or IPPC Technical Guidance Note for your sector*** and the ***IPPC Common Technical Guidance Note*** depends simply upon the availability of the former.

However, you may be proposing to operate a range of activities that are ***covered by more than one guidance note***. For example many non-combustion activities operate alongside a combustion plant. In such cases you will need to consider the issues in all of the relevant Technical Guidance notes. It is to up to you whether you follow through the methodology as separate exercises for each activity/guidance note or, alternatively, apply the methodology in the most apt guidance for the main activities and add in relevant technical considerations from the other guidance as you proceed. The outcome should be the same.

In some cases there may be ***no guidance relevant to your activities***, for example where they are novel or unusual. The default is to use the ***IPPC Common Technical Guidance Note*** for the structure. You will have to demonstrate that you evaluated a range of options and identified a complete set of techniques, technologies and other measures that you propose to apply. In such cases you should contact us to determine the most appropriateapproach.

Surface Water and Sewage Treatment /8/

Primary treatment should be employed (on or off site). The operator should justify the choice and performance of the plant against the objectives, for example the removal of oil/grease (for which the standard is for non-visible) and particulate solids. Screening, settlement and dissolved air flotation systems may be considered. The preferred solution will depend on the specific location and wastewater characteristics.

Secondary treatment should be employed (on or off site). The operator should justify the choice and performance of the plant against the objective i.e. 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.

Consideration must then be given to the fate of the sludge and whether the solution is the best option for the environment as a whole.

After the biological stage, 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.

Tertiary treatment should be consistent with the objectives of optimising water use and recovery and recycling of water where appropriate, using membrane processing. This may also aid the recover of materials from an effluent stream, thus reduce pollution loading.

Abnormal Operating Conditions /5/

Events outside your control could lead to odorous situations (e.g. extreme weather conditions or power failure where it is not BAT to provide standby). Describe the actions you propose to minimise the impact of such events (e.g. shutting down as quickly as possible or changing operating parameters). It should not include failures caused by human error, poor maintenance, predictable operational situations or weather conditions that are normal variants of local weather.

Add a section for each source/release point which may cause problems in abnormal circumstances.

Product Losses /21/

Residual beer is lost through the different production stages. The main sources of residual beer are:

- ✓ Emptying of process tanks. After the tanks are emptied some beer will remain. The amount depends on the efficiency with which the emptying is controlled.
- ✓ Kieselguhr filter. At the beginning of a filter run the filter will be full of water that is pushed out with beer. At the end of a filter run the beer is pushed out with water. These pre-runs and after-runs result in a mixture of beer and water.
- ✓ Yeast suspension through which a brewery looses about 1 - 2% of the beer production with the yeast.
- ✓ Pipes. When beer in the process pipes is pushed out with water, a mixture of water and beer will occur.
- ✓ Beer rejected in the packaging area. Beer can be rejected due to for example wrong filling height and no or incorrectly placed labels. The number of rejected bottles will depend on the brewery’s quality requirements and the equipment.
- ✓ Returned beer. Beer may be returned to the brewery if it has not been sold or if the quality is not acceptable.
- ✓ Exploding bottles in the packaging area. The bottles explode due to poor quality of the bottle, poor bottle inspection or lack of temperature control in the tunnel pasteuriser.

The total amount of residual beer lost should be in the range 1 - 5% of the total production for existing installations.

Energy Efficiency Plan /5/

An energy efficiency plan is provided below, which identifies and appraises all energy efficiency techniques applicable to the activities in the permit. All applicants should list any potential energy efficiency techniques that have not yet been implemented. This includes those listed under ”Basic energy requirements” on page xx and in ”Further energy efficiency requirements” on page xx.

Give the CO_2 savings achievable by that technique over its lifetime.

In addition to the above, applicants that do not have a climate change or trading agreement should give:

- ✓ the equivalent annual costs of implementation of the technique
- ✓ the costs per tonne of CO2 saved and
- ✓ the priority for implementation.

Include details of any which have an annualised cost of less than EUR XX/t of CO_2 or justify not doing so in the ”Proposed improvement programme” on page xx.

Refer to Energy Efficiency Guidance Note for cost appraisal methodology.

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

Add a section for each energy efficiency measure. All applicants need to answer questions about CO2 savings. If you do not have a climate change agreement or trading agreement you should also answer the questions about cost and implementation dates.

Transfer of a Permit /5/

As well as answering the questions in this section you must send us the original (not a copy) of the permit you are applying to transfer. ”*Extent of the transfer”.* This question asks if the application is for a partial transfer of the Permit. This is defined in the PPC Regulations. The answer to this question will be “no” if the transferee would become the person with control over all of the activities covered by the Permit. If, however, the current Operator wishes to retain part of the Permit - for example to continue operating some of the activities - the answer to this question is 'yes'. In the case of a partial transfer, two sets of explanatory documents must be attached to your application.

Firstly, you must explain how the operational integrity of the installation would be maintained under the proposed transfer. This should demonstrate, in particular, how any necessary inter-reliance between the applicants and their activities will be ensured.

Secondly, you must provide a map or plan identifying the part of the installation to which the proposed transfer applies. This should be prepared in accordance with the approach explained for the similar requirement that arises in respect of a new permit application under question B1.3 on Part B of the Application Form.

Non-Technical Summary /5/

You must provide a non-technical summary of your application. This should cover your answers to all the previous questions that are relevant to your application. It should follow the same order in which you have answered the questions, highlighting the main points in language that is understandable by the public. Typically, the non-technical summary for a more complex application should be around 10 pages. Summaries for very simple applications need not be more than one or two pages.

Appendix 2: The Finnish Environmental Permit Application Form

A. THE OPERATOR AND THE PLANT
   1) Operation for which a permit is sought
   2) Contact address of the operator
   3) Contact address of the plant for which a permit is sought
   4) Present valid permits and other legal decisions

B. THE SITE AND ITS SURROUNDING
   5) Facts about the site, its plants and operational activities
   6) Facts about the site's surrounding and state of the environment
   7) Survey of neighbours and other interest groups that might be affected by the operation

C. THE OPERATION
   8) General presentation of operation and a public summary of facts in the permit application
   9) Time of start-up of operation and planned close-down time
   10) Products, production, production capacity, processes, equipment, buildings and their location
   11) Raw materials, chemicals, fuels and other agents used, their storage, transportation and water use
   12) Energy use and estimated use efficiency
   13) Water supply and sewage system
   14) Assessment of environmental risks and of planned measures for risk avoidance, and contingency plans
   15) Traffic and traffic arrangements
   16) Environmental management system, if implemented

D. ENVIRONMENTAL LOADS
   17) Quality and quantity of emissions
      - ✓ Emissions to waters and sewage
      - ✓ Emissions to air
      - ✓ Emissions to the soil and ground water
      - ✓ Noise and vibration
   18) Emission reduction schemes and clean-up of polluted soils
   19) Characteristics and amount of wastes, their storage and transportation
   20) Waste minimization and re-use schemes
   21) Assessment of BAT and BEP
   22) Cross-media effects of waste reduction
   23) Assessment of the application of BEP

E. ENVIRONMENTAL IMPACTS
   24) Impacts on the environment
      - ✓ Impacts on general surrounding and health impacts

- ✓ Impacts on the surrounding nature, nature conservation values and on the built surrounding
- ✓ Impacts on surrounding water systems and on the use of water
- ✓ Impacts on the air
- ✓ Impacts on the soil and groundwater
- ✓ Impacts from noise and vibration
- ✓ Assessment of environmental impacts

F. MONITORING AND REPORTING

25) Monitoring and reporting of operation and impacts
- ✓ Monitoring of operation
- ✓ Monitoring of emissions
- ✓ Monitoring of impacts
- ✓ Monitoring systems and equipment, analytical methods and quality assurance
- ✓ Reporting and monitoring programs

G. DAMAGE VALUE

26) Estimated damage value of water pollution
- ✓ Measures for water protection
- ✓ Compensation of water system damages
- ✓ Other environmental protection measures

H. OTHER FACTS

27) Appendices
- ✓ Geographical map
- ✓ Site lay-out
- ✓ Process diagram (when necessary)
- ✓ Risk assessment if hazardous chemicals are used and stored on the site

Appendix 3: Monitoring Requirements for Waste Incineration as specified in EC Directives /11, 24/

FACILITY	DIRECTIVE or GUIDANCE DOCUMENT	POLLUTANT	CONCENTRATION (mg/m3)	MONITORING REQUIREMENT	COMPLIANCE REQUIREMENT	MEASUREMENT UNCERTAINTY
Daily average values						
WASTE INCINERATION	EC Directive 2000/76/EC	Total Dust	10	Continuous	None of daily averages can exceed limit value	30%
		TOC	10	Continuous		30%
		HCl	10	Continuous		40%
		HF	1	Continuous		40%
		SO_2	50	Continuous		20%
		NOx as NO_2 (>6 t/h)	200	Continuous		20%
		NOx as NO (<6t/h)	400	Continuous		20%
		CO	50			10%
Half-hourly average values: absolute limit/ 97 percentile limit						
WASTE INCINERATION	EC Directive 2000/76/EC	Total dust	30/10	Continuous	Either none of the half hourly average values exceeds the absolute limit or 97% of the half hourly values over the year exceed the percentile limit.	30%
		TOC	20/10	Continuous		30%
		HCl	60/10	Continuous		40%
		HF	4/2	Continuous		40%
		SO_2	200/50	Continuous		20%
		NOx as NO_2	400/200	Continuous		20%
		CO	100	Continuous		10%
All average values over the sample period of a minimum of 30 minutes and a maximum of 8 hours (6-8 hours for dioxins) New plants/existing plants						
WASTE INCINERATI ON	EC Directive 2000/76/EC	Cd+Tl	0.05/ 0.1	Twice annually	None of the average values over the sample period exceeds the emission limit.	
		Hg	0.05/ 0.1	Twice annually		
		Sb+As+Pb+Cr+Co+Cu+Mn +Ni+V	0.5/ 1.0	Twice annually		
		Dioxins and furans	0.1ng/m3 TEQ	Twice annually		

FACILITY	DIRECTIVE or GUIDANCE DOCUMENT	POLLUTANT	CONCENTRATION (mg/m3)	MONITORING REQUIREMENT	COMPLIANCE REQUIREMENT	MEASUREMENT UNCERTAINTY
HAZARDOUS WASTE INCINERATION DIRECTIVE	**EC Directive 94/67/EC**	**Total Dust**	**Daily 10 Half hourly 30 (10)**	**Continuous**	**Daily averages below limit and either all half hourly values over the year below limit, or 97% of all half hourly values in brackets below limit.**	**30%**
		VOCs as carbon	**Daily 10 Half hourly 20 (10)**	**Continuous**		**30%**
		HCl	**Daily 10 Half hourly 60 (10)**	**Continuous**		**40%**
		HF	**Daily 1 Half hourly 4 (2)**	**Periodic**		**Not specified**
		SO2	**Daily 50 Half hourly 100**	**Continuous**		**20%**
		CO	**Daily 50 Half hourly 100**	**Continuous**	**Either all half hourly values over rolling 24 hours below limit or 10 min averages over the year below 150**	**10%**
		Cd+Tl	**New 0.05 Existing 0.1**	**Twice per year**	**All average values over the sampling period of 0.5 – 8 hour period below limit. Metals and their compounds expressed as metals.**	**Not specified**
		Hg	**New 0.05 Existing 0.1**	**Twice per year**		**Not specified**
		Dioxins and furans TEQ	**0.1 ng/m3**	**Twice per year**	**Values to be below limit Sampling period of 6-8 hours**	**Not specified**

FACILITY	DIRECTIVE or GUIDANCE DOCUMENT	POLLUTANT	CONCENTRATION (mg/m3)	MONITORING REQUIREMENT	COMPLIANCE REQUIREMENT	MEASUREMENT UNCERTAINTY
LARGE COMBUSTION PLANT	**Large Combustion Plant Directive 2001/80/EC**	**SO2 (new and existing plants)**	**35 (gaseous fuel) 5 (liquified gas) 800 (coke oven, blast furnace gas and refinery residues)**	**Continuous**	**None of calendar monthly mean values to exceed the limit. 97% of all 48 mean values during the year below 110% of the limit.**	**20%**
		NOx (new and existing plants)	**600 (solid fuel) 50-500 MW 500 if > 500 MW 1300 (solid fuel with less than 10% volatile compounds) 450 (liquid fuel) 50-500 MW 400 (liquid fuel) > 500 MW 300 (gaseous fuel) 50-500 MW**	**Continuous**	**None of calendar monthly mean values to exceed the limit. 95 % of all 48 hourly mean values not to exceed 110% of the limit**	**20%**
		Total dust (new and existing plant)	**50 (solid fuel >500 MW) 100 (solid fuel <500 MW) 50 (liquid fuel) 5 (gaseous fuel) 10 (blast furnace gas) 50 (steel industry gas)**	**Continuous**	**None of the calendar monthly mean values to exceed the limit**	30%