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Integrated Pollution Prevention and Control

Reference Document on Best Available Techniques in the Food, Drink and Milk Industries

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EXECUTIVE SUMMARY

Introduction

This Reference Document on Best Available Techniques (BREF) in the Food, drink and milk industries reflects an information exchange carried out according to Article 16.2 of Council Directive 96/61/EC. This executive summary describes the main findings, a summary of the principal BAT conclusions and the associated consumption and emission levels. It should be read together with the preface, which explains this document's objectives; how it is intended to be used and legal terms. This executive summary can be read and understood as a standalone document but, as a summary, it does not present all the complexities of the full text of this document. It is, therefore, not intended to be used, as a substitute for the text of this full document, as a tool in BAT decision making.

Scope

This document reflects an exchange of information about the activities listed in Annex 1 parts 6.4. (b) and (c) of Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (IPPC Directive), i.e.

6.4. (b) Treatment and processing intended for the production of food products from:

- *animal raw materials (other than milk) with a finished product production capacity greater than 75 tonnes per day*
- *vegetable raw materials with a finished product production capacity greater than 300 tonnes per day (average value on a quarterly basis)*

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

The scope includes the whole range of activities producing food for human consumption and animal feed that may be found in European installations with capacities exceeding the above threshold values.

This document does not cover small scale activities, such as catering or activities in restaurants or activities that do not use animal or vegetable raw materials. Upstream activities such as agriculture, hunting, slaughtering of animals and the manufacture of non-food products such as soap, candles, cosmetics, pharmaceuticals; manufacture of gelatine and glue from hides, skin and bones are also excluded. Packaging is not included except for the packing of FDM products on the premises.

General information (Chapter 1)

<u>The FDM sector</u>
The FDM sector produces both finished products destined for consumption and intermediate products destined for further processing. It is diverse compared to many other industrial sectors. This diversity can be seen in terms of the size and nature of companies; the wide range of raw materials, products and processes and the numerous combinations of each as well as the production of homogenised global products and numerous specialist or traditional products on national and even regional scales. A large proportion of companies are SMEs, although most employ more than 20 people.

The FDM sector is subject to very diverse local economic, social and environmental conditions, and varying national legislation. The sector is spread all over Europe, in industrialised regions as well as in rural areas. The sector is a net exporter from the EU.

In spite of recent increased homogeneity in the consumption and purchasing patterns for a growing variety of goods, FDM products still retain elements of cultural specificity. So although consumers want to be able to purchase the same items and quality of products throughout the whole of the EU-15, they also demand the option/choice of different products linked to their own tradition or culture.

The importance of food safety in FDM processing
As well as environmental considerations, there are other legal requirements and prohibitions which must be considered when identifying BAT in the FDM sector. All FDM production installations must comply with the required food safety standards and laws. These may have an influence on environmental considerations, e.g. frequent cleaning is required and this uses heated water and detergents. Care has been taken to ensure that nothing in this document conflicts with relevant food safety and hygiene legislation.

The FDM sector and the environment
The most significant environmental issues associated with FDM installations are water consumption and contamination; energy consumption; and waste minimisation.

Most of the water which is not used as an ingredient ultimately appears in the waste water stream. Typically, untreated FDM waste water is high in both COD and BOD. Levels can be 10 – 100 times higher than in domestic waste water. The SS concentration varies from negligible to as high as 120000 mg/l. Untreated waste water from some sectors, e.g. meat, fish, dairy and vegetable oil production, contains high concentrations of FOG. High levels of phosphorus can also occur, particularly where large quantities of phosphoric acid are used in the process, e.g. for vegetable oil de-gumming, or in cleaning.

The FDM sector is dependent on energy for processing as well as for maintaining freshness and ensuring food safety.

The main sources of solid output are spillage, leakage, overflow, defects/returned products, inherent loss, retained material that cannot freely drain to the next stage in the process and heat deposited waste.

The main air pollutants from FDM processes are dust and odour. Odour is a local problem either related to the process or to the storage of raw materials, by-products or waste.

The driving forces which result in improved environmental performance are changing. For example, traditionally maximising the utilisation of materials has had the consequence of reducing waste. An approach more directly associated with protection of the environment is now emerging, although this challenges the sector, e.g. with respect to reducing water and energy consumption and the use of packaging, while still maintaining hygiene standards.

Applied processes and techniques (Chapter 2)

All of the processes used in the sector cannot be described in detail in this document, but it covers a very wide range from the whole sector. Chapter 2 is divided into two sections. Sections 2.1 – 2.1.9.6.3 describe processes at the unit operation level. Many of these are applied in several individual FDM sectors. The processes most commonly used in the FDM sector are described in nine categories, i.e. 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; and utility processes. Within each of these categories, four to fourteen unit operations are described.

Sections 2.2 – 2.2.20 describe the application of the unit operations in some of the major individual FDM sectors.

Current consumption and emission levels (Chapter 3)

Chapter 3 follows the structure of Chapter 2. In this document, as well as reporting consumption and emission data, this chapter contains additional information about outputs that are not the main final product and are not disposed of as waste, e.g. by-products.

Sections 3.1 – 3.1.4 report some overall consumption and emission data for the FDM sector as a whole and give an overview of the main reasons for its consumption and emission characteristics. The FDM sector is a large user of water as an ingredient, cleaning agent, means of conveyance and feed to utility systems. About 66 % of the total fresh water used is of drinking water quality. In some sectors, e.g. dairies and drinks, up to 98 % of the fresh water used is of drinking water quality. Process heating uses approximately 29 % of the total energy used in the FDM sector. Process cooling and refrigeration accounts for about 16 % of the total energy used.

Sections 3.2 – 3.2.56.3 report some consumption and emission levels for those individual unit operations which are described in Chapter 2. This information is reported under the headings water, air emissions, solid output, energy and noise.

Sections 3.3 – 3.3.12.3 report consumption and emission data for some individual FDM sectors. This structure enables the reader to make a comparison between individual sectors and the sector as a whole, at unit operation level. A lot of the information is qualitative. The quantitative information is often not well explained in terms of exactly what operational or technological techniques were applied and what methods or conditions of data collection were applied. Data on air emissions and waste water production are available for some individual FDM sectors and even for some unit operations. Waste minimisation is generally considered as a cost effective goal for all manufacturers but benchmarks are not readily available as the percentage of raw materials going to the final main products is variable.

The level of detail reported for each individual sector varies to a great extent.

Techniques to consider in the determination of BAT (Chapter 4)

Chapter 4 contains the detailed information used by the TWG to determine BAT for the FDM sector, but does not judge whether a technique is BAT or not. It follows the general structure of Chapters 2 and 3 by starting with information applicable to all or some of the FDM sectors and finishing with individual FDM sector specific information.

Over 370 techniques are described, generally under the standard headings Description, Achieved environmental benefits, Cross-media effects, Operational data, Applicability, Economics, Driving force for implementation, Example plants and Reference literature. The standard structure assists the comparison of techniques both qualitatively and quantitatively.

This chapter includes both "process-integrated" and "end-of-pipe" techniques. Most of the techniques are reported to 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 maximising the use of raw materials with the consequent minimisation of waste production. For many, no financial costs or benefit data were provided, but their actual application provides evidence of their economic viability.

Techniques which are applicable in all FDM installations are described first, in Sections 4.1 – 4.1.9.3. These include operational practices, i.e. management tools; training; equipment and installation design; maintenance and a methodology for preventing and minimising the consumption of water and energy and the production of waste. Other techniques are more technical and deal with production management, process control techniques and the selection of materials. General storage techniques are not reported because these are within the scope of the "Storage BREF" [95, EC, 2005]. Specific techniques related to food storage, which minimise energy consumption for refrigeration, waste and odour associated with degradation of food, are included.

Techniques which apply in a number of FDM sectors are then described in Sections 4.2 – 4.2.17.4. These deal with the way some specific unit operations which are described in Chapter 2 are applied.

Cleaning of equipment and installations is described in Sections 4.3 – 4.3.11. The selection and use of cleaning and disinfection agents must ensure effective hygiene control but with due consideration of environmental implications.

End-of-pipe techniques for minimising air emissions and for waste water treatment are described in Sections 4.4 – 4.4.3.13.2 and 4.5 – 4.5.7.9 respectively. The introductions to these sections reinforce the importance of giving priority to process-integrated techniques to prevent and reduce, as far as possible, air and waste water emissions. When end-of-pipe techniques are needed, these are designed to reduce both the concentrations and the flows of the pollutants originating from a unit operation or a process. The techniques described for minimising air emissions do not contain much information about their applicability or application in the individual FDM sectors. In contrast, the waste water treatment techniques contain more information about their applicability or application in the individual FDM sectors and address the treatment of typical emissions from FDM installations, containing high BOD, COD, FOG, nitrogen and phosphorus levels.

Sections 4.6 – 4.6.6 address the prevention of accidents at FDM installations. These sections describe a methodology for preventing accidents and minimising their impact on the environment.

Techniques which are only applicable in individual FDM sectors are described in Sections 4.7 – 4.7.9.8.2. Most of these apply to specific unit operations in the individual FDM sectors.

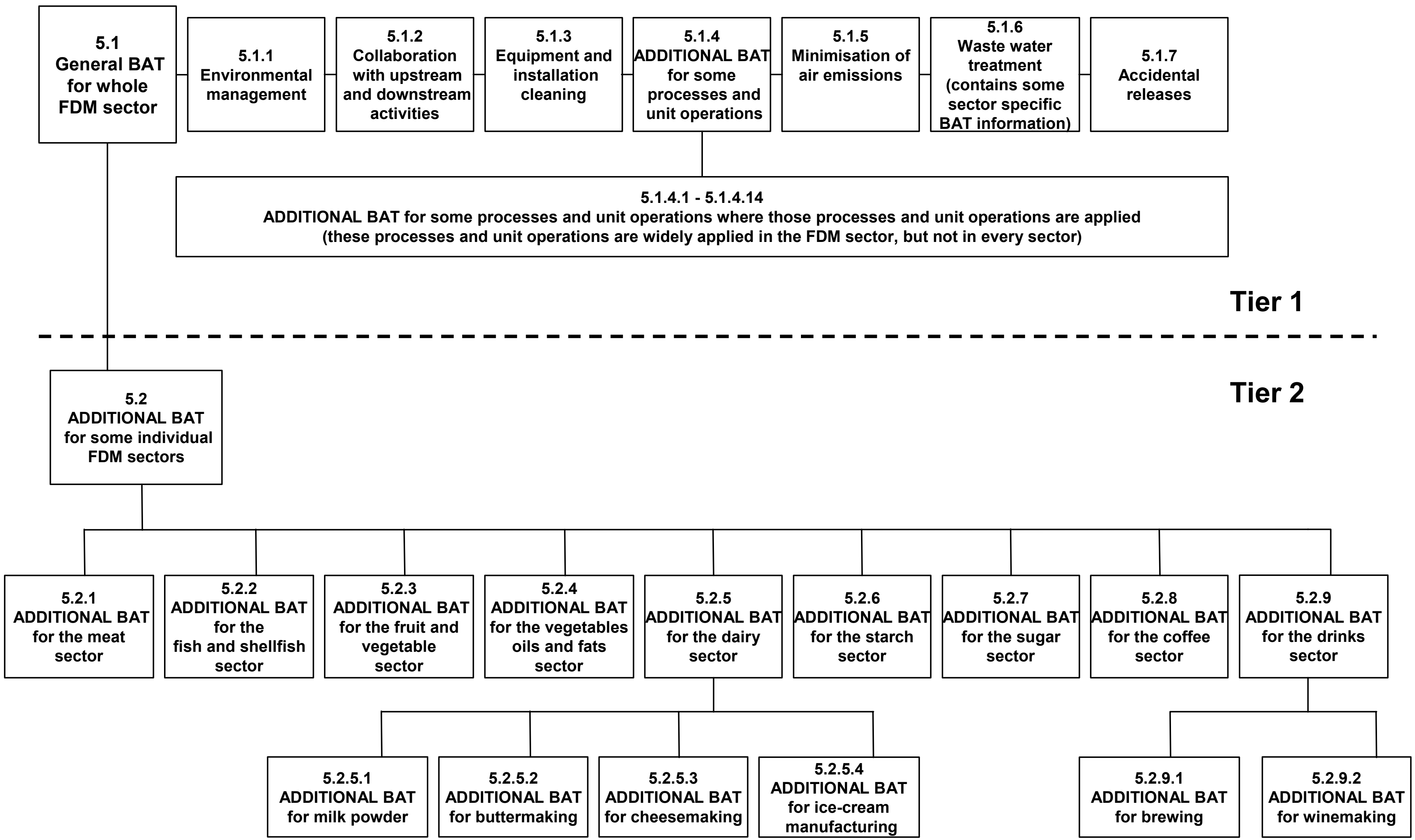
Best available techniques (Chapter 5)

The way the BAT conclusions are presented in Chapter 5 is shown in the figure below. The BAT conclusions are presented in two tiers. The first tier shows the sections listing BAT for all FDM installations and the second tier shows the sections where additional BAT for some of the individual sectors are listed. Chapter 5 follows the same structure as Chapter 4. Many of the BAT are operational and, therefore, require very little investment in new equipment. Their application may require some investment to provide, e.g. training, maintenance or ongoing monitoring and review of performance levels.

The conclusions represent what the TWG considered to be BAT in a general sense for the FDM sector based on the information in Chapter 4 and taking account of the Article 2.11 definition of “best available techniques” and the considerations listed in Annex IV to the Directive. This chapter does not set consumption and emission limit values but gives information for the guidance of industry, MSs and the public on achievable consumption and emission levels when using specified techniques.

The following paragraphs summarise the key BAT conclusions relating to the most relevant environmental issues. Very few of the BAT provide only one environmental benefit, so they are not listed according to environmental issues. The BAT take various approaches to protect the environment as a whole. These range from techniques about general management and operation, which are applicable throughout all FDM installations, to the use of very specific technology in some individual FDM sectors.

During the discussion of the information exchanged by the TWG, many issues were raised and discussed. Only some of them are highlighted in this summary and it should not be read instead of the “Best Available Techniques” chapter, which should not be read in isolation from the rest of this document.



How the BAT conclusions are presented for FDM installations

General BAT for the whole FDM sector

Although the FDM sector is diverse, the individual sectors have common issues, e.g. similar key environmental issues and the same BAT are applicable to preventing and controlling consumptions and emissions, e.g. dry cleaning, to minimise, e.g. water consumption. Also, some BAT can be applied to more than one environmental issue, e.g. maintenance of refrigeration equipment to prevent leaks of ammonia or maintenance of fish skinning machinery to minimise waste caused by unwanted removal of fish flesh during skinning.

General management

The general management BAT contribute to the overall minimisation of consumption and emission levels, by providing systems of work which encourage good practice and raise awareness. The BAT focus on issues such as using an environmental management system; providing training; using a planned maintenance programme; applying and maintaining a methodology for preventing and minimising the consumption of water and energy and the production of waste and implementing a system for monitoring and reviewing consumption and emission levels for both individual production processes and at site level.

General operation

Other BAT address some key environmental issues more directly, e.g. by transporting solid FDM raw materials, products, co-products, by-products and waste dry. This reduces water consumption and consequently also reduces waste water production and pollution. It also increases the potential for the recovery and recycling of substances generated in the process which, in many cases, can be sold for use as animal feed, so it reduces waste production.

Another example applicable to the whole FDM sector is the segregation of outputs, to optimise use, re-use, recovery, recycling and disposal and minimise waste water contamination. Numerous examples exist in the FDM sector where raw materials, partially processed foods and final products either originally intended for human consumption or from which the part intended for human consumption has been removed, may be used as animal feed. This has both environmental and economic benefits.

General application of technology

Some more technologically based BAT include the application and use of process controls, e.g. by using analytical measurement and control techniques to reduce waste of material and water and to reduce waste water generation in processing and cleaning. An example of this is measuring turbidity to monitor process water quality and to optimise both the recovery of material/product from water and the re-use of cleaning water.

Collaboration with upstream and downstream partners

The operations of those involved in the supply of raw materials and other ingredients to FDM processing installations, including the farmers and the hauliers, can have environmental consequences in those FDM installations. Likewise, the FDM installation can affect the environmental impact of those downstream installations they supply, including other FDM installations. BAT are to seek collaboration with upstream and downstream partners, to create a chain of environmental responsibility, to minimise pollution and to protect the environment as a whole, e.g. by providing fresh materials at the time they are required, which minimises the energy required to store them as well as waste and odour associated with their decomposition.

Equipment and installation cleaning

The application of BAT for cleaning, minimise water consumption and contamination; waste generation; energy consumption and the amount and harmfulness of detergents used.

In common with other BAT, the BAT for cleaning minimise the contact between water and FDM materials, by, e.g. optimising the use of dry cleaning. The environmental benefits include reduced water consumption and volume of waste water; reduced entrainment of materials in waste water and, therefore, reduced levels of, e.g. COD and BOD. Use of the various dry cleaning techniques increases the potential for the recovery and recycling of substances generated in the process. It also reduces the use of energy needed to heat water for cleaning and the use of detergents.

Other BAT associated with cleaning include cleaning-in-place of closed equipment, minimising the use of EDTA and avoiding the use of halogenated oxidising biocides.

Additional BAT for some processes and unit operations applied in a number of FDM sectors
The TWG reached BAT conclusions for some of the individual unit operations which are applied in a number, but usually not all, of the individual FDM sectors. BAT are listed for materials reception/despatch; centrifugation/separation; smoking; cooking; frying; preservation in cans, bottles and jars; evaporation; freezing and refrigeration; packing; energy generation and use; water use; compressed air systems and steam systems. The application of many of these BAT achieves reduced energy consumption, e.g. by using multi-effect evaporators, optimising vapour recompression related to heat and power availability in the installation, to concentrate liquids. Many reduce energy consumption by optimising operating conditions. Some reduce emissions to air. For example in smoking, BAT is to achieve a TOC air emission level of <50 mg/Nm^3.

Minimisation of air emissions and waste water treatment
Process-integrated BAT which minimise emissions to air and water by the selection and use of substances and techniques should be applied. The selection of air emission abatement and waste water treatment techniques can then be made, if further control is required. For example, BAT is to optimise the use of dry cleaning and this reduces the volume of waste water and the mass flow of solid food materials in it, so also reducing the requirement for waste water treatment.

BAT is to apply an air emissions control strategy and, unless specified otherwise in the BAT chapter, where process-integrated BAT which minimise air emissions by the selection and use of substances and the application of techniques do not achieve emission levels of 5 - 20 mg/Nm^3 for dry dust, 35 – 60 mg/Nm^3 for wet/sticky dust and <50 mg/Nm^3 TOC, to achieve these levels by applying abatement techniques.

No overall conclusions were reached about whether it is better to treat waste water from FDM installations on-site or off-site, except for some primary techniques.

Unless otherwise stated in the BAT chapter, the emission levels given in the following table are indicative of the emission levels that would be achieved with those techniques generally considered to represent BAT. They do not necessarily represent levels currently achieved within the industry but are based on the expert judgement of the TWG.

Parameter	**Concentration (mg/l)**
BOD_5	<25
COD	<125
TSS	<50
pH	6 – 9
Oil and grease	<10
Total nitrogen	<10
Total phosphorus	0.4 – 5
Better levels of BOD_5 and COD can be obtained. It is not always possible or cost effective to achieve the total nitrogen and phosphorus levels shown, in view of local conditions.	

Typical FDM waste water quality after treatment

One MS has registered a split view. It does not agree with the footnote in the table shown above, because it believes that deviations from BAT, e.g. due to local conditions, are exclusively allowed to strengthen the requirements of permits.

Accidental releases
Several BAT are listed related to identifying potential accidents, risk assessments, implementing controls, developing and testing emergency plans and learning from past accidents and near misses.

Additional BAT for some individual FDM sectors
Additional BAT have been determined for the some individual FDM sectors. The general BAT in Sections 5.1 – 5.1.7 apply to these sectors and to the other sectors for which no additional BAT have been determined. The application of, e.g. general BAT such as segregation of outputs and optimising the use of dry cleaning can significantly reduce the overall environmental impact of a process.

The additional BAT for the meat and poultry sector apply to specific unit operations applied in some parts of that sector. They reduce the consumption of water, energy and packaging.

The main environmental benefits of the additional BAT for the fish and shellfish sector are reduced waste and less water consumption and several apply to the thawing, scaling, skinning, eviscerating and filleting of fish. For example, BAT have been determined for thawing mackerel to achieve a water consumption of <2 m^3/t of raw fish; for thawing whitefish to achieving a water consumption of 1.8 – 2.2 m^3/t of raw fish and to thaw shrimps and prawns by one or other of the two techniques using filtered peeling water.

For the fruit and vegetables sector, the BAT address storage, dry separation of rejected raw material, collection of soil, peeling, blanching and optimising water re-use. Application of the BAT lead to maximised production yield; material not used in the main product being used for other purposes, often as animal feed and consequently reduced waste generation. The environmental benefits of applying the BAT for storage, peeling and blanching include, e.g. reducing energy consumption.

The environmental benefits of applying the additional BAT for the vegetable oils and fats sector are mainly the reduction of energy consumption and the recovery of hexane used during extraction. One BAT associated emission level was determined, i.e. BAT is to use cyclones, to reduce wet dust emissions arising from vegetable oil extraction, to achieve a wet dust emission level of <50 mg/Nm^3.

There are additional BAT for dairies and specific BAT for producing market milk, powdered milk, butter, cheese and ice-cream. The BAT apply to specific parts of the processes and to cleaning. They address water consumption, energy consumption and waste prevention. There are both operational and technological BAT. Consumption and emission levels indicative of the levels that can be achieved by applying in-process BAT have been determined, based on achieved levels reported by the TWG. These ranges are shown in the following table. The ranges reflect a variety of operating conditions. Energy consumption levels may vary due to, e.g. production volumes. Warm climates may use more energy for cooling and vice versa. Water consumption and waste water emission levels may vary due to, e.g. different product portfolios, batch sizes and cleaning. The waste water emission level may be lower compared to the water consumption level because many dairies measure the intake of cooling water, but then discharge it unmeasured. In warm climates, water may be lost due to evaporation.

	Energy consumption	Water consumption	Waste water
Production of market milk from 1 litre of received milk	0.07 – 0.2 kWh/l	0.6 – 1.8 l/l	0.8 – 1.7 l/l
Production of milk powder from 1 litre of received milk	0.3 – 0.4 kWh/l	0.8 – 1.7 l/l	0.8 – 1.5 l/l
Production of 1 kg of ice-cream	0.6 – 2.8 kWh/kg	4.0 – 5.0 l/kg	2.7 – 4.0 l/kg

Consumption and emission levels associated with some dairy processes

The application of the additional BAT for starch manufacturing mainly address reducing water consumption and waste water production, especially by re-using water.

Re-use of water is also addressed by the BAT for the sugar sector. Minimising energy consumption is also achieved by avoiding drying sugar beet pulp if an outlet is available for pressed sugar beet pulp, e.g. animal feed; otherwise to dry sugar beet pulp using steam driers or using high temperature driers combined with measures to reduce emissions to air.

The main environmental issues addressed by the application of the additional BAT for the coffee sector are related to energy consumption and emissions to air, including odour. When roasting coffee, where process-integrated BAT which minimise air emissions by the selection and use of substances and the application of techniques do not achieve emission levels of 5 - 20 mg/Nm^3 for dry dust; <50 mg/Nm^3 TOC for light roasted coffee (this level is more difficult to achieve as the darkness of roasting is increased); BAT is to achieve these levels by applying abatement techniques. Emission levels for NO_x were provided too late for full verification by the TWG, these are reported in the concluding remarks.

The additional general BAT for drinks manufacturing address avoiding production of CO_2 directly from fossil fuels, recovery of yeast, collection of spent filter material and the selection and optimised use of bottle cleaning machines. Application of the additional BAT for brewing reduce both water and energy consumption. For brewing, BAT is to achieve a water consumption level of 0.35 – 1 m^3/hl of beer produced. The application of the additional BAT for winemaking re-uses the alkaline solution used for cleaning after cold stabilisation and addresses the method of its ultimate disposal to prevent disruption of the waste water treatment plant.

Emerging techniques (Chapter 6)

Chapter 6 includes one technique that has not yet been commercially applied and is still in the research or development phase. This is "Use of UV/ozone in absorption for odour abatement". It has been included here to raise awareness for any future revision of this document.

Concluding remarks (Chapter 7)

Timing of the work
The work on this document started with the first plenary meeting of the TWG in January 2001. The final plenary meeting of the TWG was held in February 2005.

Level of consensus, driving forces and issues arising from the final TWG meeting
The conclusions of the work were agreed at the final plenary meeting, with a high level of consensus being achieved, however some issues were raised at the meeting and it is recommended that these be considered further when this document is reviewed.

Information provided
Many reports from MSs and industry were used as sources of information in the drafting of this document, including information from example plants and site visits. The participation of individual MSs in the work, to an extent, reflected the regional distribution of the sectors. CIAA and its member organisations provided most of the industry contributions.

The information exchange and the preparation of this document has been a positive development in the prevention and control of pollution for the sectors concerned. It has provided a first-time opportunity for individual sectors to learn about techniques that have been proven to work well in others, on a Europe-wide scale.

Information imbalances and gaps
There is a vast difference in the level of detail of information provided about individual FDM sectors and there are also differences in the coverage of the key environmental issues in this document. The current consumption and emission level data provided were not linked with process descriptions, operating conditions, installation capacity, sampling and analytical methods and statistical presentations. Techniques which can reduce energy consumption are described in this document, but very few actual measurements of energy savings associated with the application of those techniques or about the economics of investing in techniques and the resultant cost savings were provided. Benchmarks for waste minimisation are not provided, e.g. there is no detailed information about what proportion of specified raw materials end up being used in products or by-products.

Recommendations for future work

The gaps in the information indicate areas where future work could provide results which might assist in the identification of BAT when this document is reviewed, thereby helping operators and permit writers to protect the environment as a whole. It is recommended that information be provided about the following:

- process descriptions, operating conditions, sampling and analytical methods, and statistical presentations associated with consumption and emission level data
- the full range of applicability of techniques in this document
- further opportunities for by-product valorisation to minimise waste generation
- the costs of investing in and operating techniques and the associated direct and indirect savings, e.g. due to reduced energy or waste disposal costs, or reduced losses from unintentional losses due to leakage or spills
- the determination of BAT associated with high, medium and low pressure cleaning
- substances already in use as a alternatives to EDTA in cleaning
- the application and applicability of air abatement techniques in the FDM sector
- the application of non-thermal plasma treatment of odours in the FDM sector
- techniques to prevent the discharge of condensed alcohol into the waste water treatment plant, from the production of non-alcoholic beer
- how seasonal activities affect the technical and economic viability of techniques
- techniques for extracting olive oil and in particular about “two-phase extraction”
- the use of enzymatic interestification and enzymatic degumming of vegetable oils
- comparative information about the degumming of vegetable oils using enzymes, phosphoric acid and citric acid
- techniques used to minimise NO_x emissions from coffee roasting installations and
- the selection and use of fumigants.

Suggested topics for future R&D projects

The following topics are suggested for future research and development projects:

- the composition and harmfulness of malodorous emissions from FDM installations
- identification of techniques to reduce the lowest levels of NO_x emissions reported from coffee roasting
- identification of alternatives to using EDTA as a cleaning agent and
- the environmental benefits and costs of reverse osmosis.

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