How to comply with your environmental permit
Additional guidance for:

The Food and Drink Sector (EPR 6.10)

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The Environment Agency. Out there, making your environment a better place.

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Introduction

Introduction

In *"Getting the basics right – how to comply with your environmental permit"* (GTBR) we described the standards and measures that we expect businesses to take in order to control the risk of pollution from the most frequent situations in the waste management and process industries.

This sector guidance note (SGN) is one of a series of additional guidance for Part A(1) activities listed in Schedule 1 of the Environmental Permitting Regulations (the Regulations). We expect you to use the standards and measures in this note **in addition** to those in GTBR to meet the objectives in your permit.

Sometimes, particularly difficult issues arise such as problems with odour or noise. You may then need to consult the "horizontal" guidance that gives in depth information on particular topics. Annex 1 of GTBR lists these.

The IPPC Directive requires that the Best Available Techniques (BAT) are used. When making an application, explain how you will comply with each of the indicative BATs in this sector guidance note. Where indicative BAT is not included, where you propose to use an alternative measure or where there is a choice of options you should explain your choice on the basis of costs and benefits. Part 2 of Horizontal Guidance Note H1 Environmental Risk Assessment (see GTBR Annex 1) gives a formal method of assessing options which you should use where major decisions are to be made.

We will consider the relevance and relative importance of the information to the installation concerned when making technical judgments about the installation and when setting conditions in the permit.

Modern permits describe the objectives (or outcomes) that we want you to achieve. They do not normally tell you how to achieve them. They give you a degree of flexibility.

Where a condition requires you to take appropriate measures to secure a particular objective, we will expect you to use, at least, the measures described which are appropriate for meeting the objective. You may have described the measures you propose in your application or in a relevant management plan but further measures will be necessary if the objectives are not met.

The measures set out in this note may not all be appropriate for a particular circumstance and you may implement equivalent measures that achieve the same objective. In cases where the measures are mandatory this is stated.

Introduction

In response to the application form question on Operating Techniques, you should address each of the measures described as indicative BAT in this note as well as the key issues identified in GTBR.

Unless otherwise specified, the measures and benchmarks described in this note reflect those of the previous Sector Guidance Note. They will be reviewed in the light of future BREF note revisions. In the meantime we will take account of advances in BAT when considering any changes to your process.

Installations Covered

This note applies to activities regulated under the following section of schedule 1 of the Regulations:

Section 6.8 - the treatment of animal and vegetable matter and food industries: sections (d) and (e) Part A(1)

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

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

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

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

Directly associated activities

The installation will also include **directly associated activities** which have a technical connection with the main activities and which may have an effect on emissions and pollution.

Key Issues

The key issues in the Food and Drink Sector are:

Accident management

Many materials used by the sector have high oxygen demand, and spills and leaks into the water environment can be serious events. In addition to preventing spills and process leaks, you should take particular care to avoid overfilling of vessels, failure of containment, wrong drainage connections and blocked drains.

Introduction

Releases associated with energy use

The industry is a major energy user. There remain significant opportunities for reduction of emissions caused by energy use and choice of energy source (CO_2, SOx, NOx, etc., contributing in particular to global warming and acidification).

Water use

The sector uses large volumes of water for moving, cleaning and processing materials. By reducing water use, you will often make it easier to handle the resulting waste water. There are a number of opportunities to either re-use water (for example low-grade wash waters) or to recycle water from, for example, membrane systems (also see Hygiene and food safety below).

Waste minimisation

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

Emissions to air

Many food and drink processes emit volatile organic compounds (VOCs) and odour, for example, from cooking and drying processes. Emissions of dust and particulate can also be a factor from activities such as mixing, grinding, milling and transfer of materials. Odour can be problematic because emissions tend to be fugitive. Refrigeration and cooling systems can also give rise to fugitive emissions.

Emissions to water

Other than the predominantly "dry" activities, for example milling, most food and drink processes generate wastewaters. The composition of the effluent is highly variable, dependent on the activity, working patterns, product wastage and cleaning systems. It is very important that you keep raw materials, intermediates, product and by-product out of the wastewaters as far as practicable by controlling product wastage and cleaning processes.

Hygiene and food safety

Hygiene and food safety is of fundamental importance to the food and drink sector. It will sometimes restrict your choice of technique, especially in measures relating to water use, cleaning, re-use and recycling of water

1

Managing your activities

Accident management
Energy efficiency

1. Managing your activities

1.1 Accident management

Indicative BAT

You should where appropriate:

1. Use automatic process controls backed-up by manual supervision, both to minimise the frequency of emergency situations and to maintain control during emergency situations. Instrumentation will include, where appropriate, microprocessor control, trips and process interlocks, coupled with independent level, temperature, flow and pressure metering and high or low alarms.
2. Use techniques and procedures to prevent overfilling of tanks - liquid or powder- (*eg*. level measurement displayed both locally and at the central control point, independent high-level alarms, high-level cut-off, and batch metering).
3. Use measures to detect variation in effluent composition *eg* in-line TOC measurement (see monitoring section)
4. Ensure that gross fat, oil and grease (FOG) does not block drains.
5. Identify the major risks associated with the effluent treatment plant (ETP) and have procedures in place to minimise them.
6. Provide adequate effluent buffer storage so that you can stop spills reaching the ETP or controlled water, especially those spills with high organic strength.
7. Protect against spillages and leaks of refrigerants, especially ammonia.

1.2 Energy efficiency

Indicative BAT

You should where appropriate:

1. Recover heat from, for example, ovens, dryers, fryers, evaporators, pasteurisers and sterilisers, where a plate heat exchanger has a regeneration capacity up to 94%.
2. For in-tunnel and tray ovens, fit heat exchangers to the exhaust flues to remove heat from exhaust gases and to heat inlet air.
3. Recover heat from condensed steam, for example, blanching and steam peeling.

Energy efficiency
Efficient use of raw materials and water

4. Use multi-effect evaporators in large scale evaporator applications.
5. Minimise water use and use recirculating water systems.
6. Ensure efficient operation of the refrigeration system – consider heat recovery from refrigeration system, reducing heat load, efficient operation on part load and fast closing doors/alarms on chilled storage areas.
7. Use spent cooling water (which is raised in temperature) in order to recover the heat.
8. Optimise efficiency measures for combustion plant, *e.g.* air/feedwater pre-heating, and use of excess air.

1.3 Efficient use of raw materials and water

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

In many installations the best conventional effluent treatment produces a good water quality. This may be reused in the process directly or in a mixture with fresh water. Treated waste water can vary in quality. Where this is the case it can be recycled selectively when the quality is adequate, and discharged when the quality falls below that which the system can tolerate.

Membrane technology produces a high quality permeate suitable for re-use (potable water can be generated using this technique) and the retentate may be recoverable as a by product. The cost of membrane technology continues to reduce and these technologies can be applied at the unit process or to the final effluent from the ETP. They can, ultimately, be a complete replacement for the ETP, leading to much reduced effluent volume, and if combined with evaporation using waste heat, lead to potentially effluent-free systems.

Although the selection of the primary raw material (the foodstuff ingredients) is fixed by the requirements of the product, some significant pollution impacts are associated with the primary raw materials. These can range from materials such as soil attached to root crops, to pesticides and herbicides connected with the source crop. Other than foodstuffs and energy, water is the main raw material. The other important class of raw materials are the auxiliary chemicals (see Table 1 below).

Efficient use of raw materials and water

Table 1 Auxiliary materials

Raw material	Purpose	Summary of potential environmental impacts
Organic solvents	Extraction of food components	Solvents used include methylene chloride, acetone, ethyl ether, hexane, heptane and cyclohexane. They exhibit a range of toxicity, flammability and volatility, and present an accident risk and a source of VOC emissions
Salt, sodium nitrate and nitrite	Brining and curing agents	Wash down into effluent will affect effluent quality. Chloride (brine) is a conservative substance and is, therefore, not reduced through effluent treatment, apart from dilution
Caustic	Fruit and vegetable peeling	Produces a high pH wastewater
Citric acid	Blanching aid	Produces a low pH wastewater
Ferrous sulphate	Water treatment	Spillage or incorrect use will create an acidic solution
Chlorinated water	Washing	
Ammonia	Refrigerant	Very potent pollutant in event of spillage into watercourse or sewer. Leaks from refrigeration system will result in emissions to air
Ethylene glycol and water	Refrigerant	Has a high oxygen demand in event of spillage into watercourse or sewer
R404 and R22 (HCFC)	Refrigerant	Leaks from refrigeration system will result in emissions to air and these refrigerants are contributors to ozone depletion
Packaging		Excess will require recycling or disposal
Cleaning agents including strong acids, bleach and biocides	Cleaning and sanitisation	Even in the diluted form used for cleaning purposes a proportion of the chemicals will end up in the final effluent, even if much reduced by treatment. Potent pollutants in the event of spillage into a watercourse or sewer

Efficient use of raw materials and water

Indicative BAT

You should where appropriate:

1. Identify and evaluate opportunities for the recycling or reuse of water, taking into consideration hygiene issues and practical constraints. An optimal scheme is likely to include a combination of:
    - sequential reuse (water stream used for two or more processes or operations before disposal)
    - counter-flow reuse, in which the water flows counter-current to the product so that the final product only comes into contact with clean water
    - recycling within a unit process or group of processes without treatment. Recirculating systems should be used to recycle water. (Once through cooling systems should not be used.)
    - the recycling of condensate as boiler feed water (where it is of suitable quality). Contaminated condensate should be used for lower grade cleaning activities e.g. yard washing
    - recycling following treatment - this may include tertiary treatment such as membrane technology.
2. Assess the potential environmental impact of raw materials and make substitutions where appropriate. Consider their degradation products when choosing cleaning materials. If caustic is used low mercury sodium hydroxide should be selected. Supercritical carbon dioxide is a suitable alternative to organic solvent useage for extraction of caffeine.

Avoidance, recovery and disposal of wastes

1.4 Avoidance, recovery and disposal of wastes

Indicative BAT

You should where appropriate:

1. Demonstrate that the chosen routes for recovery or disposal represent the best environmental option considering, but not limited to, the following:
   - all avenues for recycling back into the process or reworking for another process
   - composting
   - animal feed
   - other commercial uses, as tabulated in table 2 below
   - landspreading, but only under the following circumstances
     - you can demonstrate that it represents a genuine agricultural benefit or ecological improvement
     - you have identified all the pollutants likely to be present. These may substances from the process, from the materials of which your plant is constructed (e.g. reaching the waste by corrosion/erosion mechanisms), from materials related to maintenance (e.g. detergent). You should consider all these possibilities, for both normal and abnormal operation of the plant. You should validate your conclusions by chemical analysis of the waste.
     - You have identified the ultimate fate of the substances in soil.
2. Schedule production to minimise product changeovers and clean downs.
3. Consider whether your packing line efficiency can be improved.

Table 2 Potential uses of waste

Waste	Potential use
Orange peel	Dietary fibre
Potato pulp	Production of bioethanol
Bread crumbs	Production of sourdough
Brewery grain	Mushroom compost, vermiculture
Fish	Protein hydrolysates
Onions	Onion oil, fructo-oligosaccharides, pectic polysaccharides, low-lignin dietary fibre

2

Operations

Operating techniques

2. Operations

2.1 Operating techniques

It is important that all plant, including process monitoring and control equipment is designed, installed, calibrated and operated so that it will not interfere with hygiene conditions in the production process and thus lead to product loss and waste.

Product loss is a significant benchmark for the food and drink industry, and you should assess your performance against the benchmarks. Specific machines or departments can be assessed or a complete factory effluent audit conducted, itemising the effluent loadings from all manufacturing and cleaning processes.

You may need to invest in pipework or recovery systems, but this can be offset against the potential savings. Often changes in working practices or techniques will provide savings without the need for any additional expenditure. This is often where factory personnel provide the best input for suggestions and information

Measures, which should be implemented as appropriate, include those tabulated below:

Table 3: Process monitoring and control equipment

Technique	Application	Outcome
Temperature measurement	Storage and processing vessels, transfer lines etc	Reduced deterioration of materials and out of specification products
Pressure measurement	Indirect control of other parameters, for example flow or level	Minimise waste from material damaged by shear friction forces
Level measurement	Storage and processing vessels	Prevent overflow from storage or processing tanks.
Flow measurement	Transfer lines	Accurate addition of materials to processing vessels and minimise excessive use of materials and formation of out of spec products
	Steam supply	Maintain correct operating

Operating techniques
Process control

		temperature and minimise waste from over heated or underheated 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

2.2 Process control

Indicative BAT

You should where appropriate:

1. Assess your product loss against the benchmarks.
2. Set up effluent monitoring to provide baseline information on wastewater loadings (kgCOD and volume).
3. Investigate high loss areas. Using the baseline information you should set improvement targets - this could be a reduction in daily kgCOD or volume, or any other specific objective.
4. Continue monitoring and review your performance regularly.
5. Carry out any appropriate measurements listed in Table 3 above.

Raw materials preparation

2.3 Raw materials preparation

Feedstock cleaning

Washing and soaking of feedstock may give rise to odours that require treatment (see Horizontal Guidance Note H4 Odour). Reuse and recycling of water is important (see efficient use of raw materials and water section above).

Dry cleaning is used for products with low moisture content and mechanical strength e.g. grains and nuts. The main types of equipment are:

1. air classifiers
2. magnetic separators
3. sieves and screens.

These may give rise to dusty emissions to air which require abatement and noise which may require consideration at the design stage.

Sorting, screening, grading and trimming

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

The main control issues are as described for dry cleaning in the above paragraph.

Peeling

Peeling can be a major source of biological oxygen demand (BOD) and total suspended solids (TSS), and can give rise to a substantial proportion of the total wastewater volume. Control issues include emissions to air (odour and VOCs), effluent treatment, waste handling, waste recovery and disposal.

Conventional steam or hot water peeling uses large quantities of water (up to four times that required for caustic peeling) and produces wastewater with high levels of product residue. At potato processing installations, the peels can contribute up to 80% of the total BOD.

Raw materials preparation

Dry caustic peeling methods can greatly reduce the volume and strength of the wastewater from the peeling operation and allow for the collection of peel as a pumpable slurry. The use of caustic in peeling may lead to pH fluctuations in the wastewater. Some produce (e.g. tomatoes) requires strong caustic solutions and the addition of wetting agents. Dry caustic peeling tends to have a lower caustic consumption than wet methods.

Flash steam peeling is a batch process. Most of the peeled material is discharged with the steam, which results in the collection of a concentrated waste stream. Remaining traces are sprayed off with water. The process has a lower water consumption than other "wet" peeling methods.

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

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

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

Indicative BAT

You should where appropriate:

1. When choosing a peeling technique or when replacing peeling plant, show that your selection has taken into account water efficiency, energy efficiency and product loss.

Heat processing using steam or water

2.4 Heat processing using steam or water

Blanching

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

Blanching produces a low-volume, high-strength effluent and may cause odour. The main control issues are water use (blanching water may be reused in other parts of the process), cleaning techniques, emissions to air (dust and odour), effluent treatment and energy efficiency, all of which are addressed in appropriate sections in this note.

Evaporation

Evaporation is used to pre-concentrate food, increase the solid content of food and to change the colour of food, and is used to process milk, starch, coffee, fruit juices, vegetable pastes and concentrates, seasonings, sauces, and in sugar processing.

Evaporation systems may be single-stage or multi-stage (also called “effects”) with 2, 3 or more evaporator or vacuum units. Evaporation produces copious quantities of hot water, suitable for boiler feed make-up and potential re-use within the factory (e.g. CIP make-up).

Indicative BAT

You should where appropriate:

1. Reduce energy consumption by re-using heat contained in vapours by, for example:
    - vapour recompression
    - or by using the vapour to pre-heat incoming feedstock or condensed vapour which is then used to raise steam in a boiler.
2. Install a condensate re-use system (as above – see efficient use of raw materials and water).

Heat processing using steam or water

Pasteurisation, Sterilisation, UHT

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

Indicative BAT

You should where appropriate:

1. Use recirculating systems to recycle water. (Once through cooling systems should not be used.)
2. Use energy efficiency techniques including regenerative heat exchangers.

Baking, roasting, drying (liquid/solid) and dehydration (solid/solid)

The main issues associated with these processes are energy efficiency, combustion products, dust and odour.

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

Roasting causes the emission of VOCs, many of which are odorous.

Typical applications of drying technologies include milk, coffee, tea, flavours, powdered drinks and sugar, among others.

Fluidised bed dryers offer several advantages, including:

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

Heat processing using steam or water
Cooling, chilling, freezing or freeze-drying

Indicative BAT

You should where appropriate:

1. Consider the following energy efficiency measures:
   - use of exhaust air to pre-heat inlet air
   - use of direct flame heating by natural gas
   - two stage drying
   - pre-concentrating liquid foods using multiple effect evaporation.
2. Use low NOx burners.
3. Ensure extraction to efficient abatement plant.

Frying

The main control issues are emissions to air, removal of entrained oil from exhaust gases, exhaust gas recirculation to the burner, odour, energy efficiency and recovery of heat in off-gases.

2.5 Cooling, chilling, freezing and freeze drying

The main control issues are water use, cleaning techniques, fugitive emissions to air (refrigerants) and energy efficiency.

Indicative BAT

You should where appropriate:

1. Use recirculating systems to recycle water. (Once through cooling systems should not be used.)
2. Use detailed drainage plans to ensure that ammonia leaks cannot be discharged to surface waters.
3. Energy efficient techniques should be applied (see energy efficiency section above).

Separation and concentration of food components Cleaning and sanitation

2.6 Separation and concentration of food components – extraction

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

- water
- organic solvents like hexane, dichloromethane, ethyl acetate and ethanol (alcohol)
- supercritical carbon dioxide.

The main control issues are fugitive emissions to air (refrigerants), water use and energy efficiency.

2.7 Cleaning and sanitation

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

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

Sanitation chemicals and techniques

There are three main types of sanitising technique:

- Oxidising biocides, typically strong oxidising agents such as chlorine/bromine, ozone and hydrogen peroxide. The main disadvantage of chlorine-based chemistry is the ability of chlorine to react with a wide number of other compounds and so reduce the "effective" chlorine dose rate.
- Non-oxidising biocides, typically quaternary ammonium salts and formaldehyde/ glutaraldehyde.
- UV light at 254 nm. The main advantages of UV disinfection over other techniques include no storage or use of dangerous chemicals, the absence of harmful by-products (no organohalogens) and a simple technology with relatively low capital and operating costs.

Cleaning and sanitation

UV light also causes an immediate reaction and therefore does not impart any residual effect, with treated waters liable to re-infection. The main disadvantage of UV disinfection is that a direct line of sight must be maintained between the lamp and the bacteria/virus. Any appreciable levels of suspended solids (hence decreasing transmissivity) will shield the bacteria and prevent their disinfection.

Indicative BAT

You should ensure that appropriate cleaning procedures are in place. These should include measures such as the following:

1. Wherever possible raw materials and product should be kept out of the wastewater system.
2. **Equipment design:**
    - when ordering new equipment consider ease of cleaning
    - wherever practicable, process lines and operations that cause excessive spillage of material onto the floor should be modified to eliminate or reduce the problem
    - dry clean-up procedures should remove as much residual material as possible from vessels and equipment before they are washed
    - drains should be equipped with catchpots
    - catchpots should be in place during cleaning (for example by installing lockable catchpots)
    - you should optimise water pressure at jets, nozzles and orifices
    - trigger operated spray guns or hoses should have an automatic water supply shut off.
3. **Good housekeeping:**
    - you should install trays to collect waste to prevent it falling to the floor
    - spilt material should be swept, shovelled or vacuumed rather than hosed down the drain
    - you should make sure that suitable dry clean-up equipment is always readily available
    - you should provide convenient, secure receptacles for the collected waste
    - cleaning schedules should be optimised
    - cleaning cycle durations should be matched to the vessel size
    - you should schedule product manufacture to minimise numbers of product changes and subsequent cleaning between products.

Cleaning and sanitation

4. **Manual cleaning:**
    - procedures should ensure that hoses are only used after dry clean-up
    - trigger controls should be used on hand-held hoses and water lances to minimise the use of washdown water
    - high-pressure/low-volume systems should be used wherever practicable
5. **Cleaning chemicals usage:**
    - you should ensure that staff (and contract cleaners) are trained in the handling, making up and application of working solutions. In particular, the correct concentration of chemical agent should be used. Overuse of chemicals should be avoided, particularly where manual dosing is used.
6. **Cleaning-in-place (CIP):**
    - dry product should be removed before the start of the wash cycle by gravity draining, pigging or air blowdown
    - pre-rinsing should be used to enable remaining product to be recovered for re-use or disposal
    - the use of turbidity detector to maximise product recovery
    - optimal CIP programme for the size of plant/vessel and type of soiling
    - optimising frequency and duration of rinses to reduce water use
    - automatic dosing of chemicals at correct concentrations
    - internal recycling of water and chemicals
    - recycle control on conductivity rather than time
    - continuous cleaning of recirculated solutions
    - water-efficient spray devices
7. Use dry clean-up techniques where practicable to reduce wastewater strength.
8. **Sanitisation:**
    - you should justify the use of organohalogen-based oxidising biocides over the alternatives (e.g. ozone and UV light)
    - recycling of water and recovery of cleaning chemicals

3

Emissions and monitoring

3.1 Point source emissions
3.2 Fugitive emissions
3.3 Odour
3.4 Monitoring

Point source emissions

3. Emissions and monitoring

3.1 Point source emissions

Point source emissions to air

Heat recovery systems on indirect fired ovens and fryers utilise exhaust air for pre-heating and also recycle the exhaust gas to the heater. As well as being energy efficient, the combustion of recycled exhaust gas can reduce NOx emissions to atmosphere. Any cost-benefit analysis should consider both environmental advantages.

Indicative BAT

You should where appropriate:

1. Meet the benchmark values for point source emissions to air listed in Annex 1 of this guidance, unless you justify alternative values and obtain our agreement to them.
2. Use heat recovery systems.
3. Recycle exhaust gas where practicable for pre heat purposes.

Annex 2 provides information on some abatement options for specified pollutants.

Point source emissions to water

Wastewater can be variable in composition, depending on production patterns and when cleaning (often the largest source of wastewater) takes place. It may vary in pH from 3.5 – 11, have a suspended solids content of up to 120,000 mg/litre, and typically has a high BOD/COD. It may contain high concentrations of fats, oils and greases (FOG). Sometimes pathogenic organisms in the wastewater may be a problem, especially where meat and fish are being processed. While the wastewater is largely biodegradable, it may contain substances that will interfere with biological treatment e.g. salinity (in a plant making pickles or cheeses), pesticide residues, residues and by-products from the use of chemical disinfection techniques, and some cleaning products.

Although BOD/COD is likely to be high, you can make a significant difference by preventing raw materials and wastes from entering the wastewater system and by avoiding excessive or inappropriate use of cleaning chemicals.

Details of BAT for wastewater treatment in different sub-sectors are given in the relevant BREF notes. You should refer to

Point source emissions

these when assessing your own techniques against BAT. The factors that should normally be considered are given below:

Indicative BAT

You should where appropriate:

1. As a minimum, control all emissions to avoid a breach of water quality standards but where another technique can deliver better results at reasonable cost it will be considered BAT and should be used. Unless self-evident, you should provide calculations and/or modelling to demonstrate this as part of your application.
2. Keep raw materials and product out of the wastewater system wherever possible. The following techniques should be used:
   - dry clean-up
   - installation of drain catchpots and screens
   - where gross FOG is found in wastewater, drainage systems should have grease traps and gratings to prevent sewer blockage. These must be frequently inspected, emptied and maintained
   - use a balancing tank or pond (equalisation or balancing), with a hydraulic retention time of 6 – 12 hours, which can improve treatment in the following ways:
     - by allowing waste streams to be combined e.g. acid and alkali streams from the regeneration of deionisers; or high BOD and low BOD waste streams. This can reduce consumption of reagents
     - by making the flow rate less variable. This can reduce the size of the treatment plant needed, as it only has to handle the average flow and not the peak flow.
3. Provide contingency measures to prevent accidental discharges from overloading or damaging the treatment plant. These will often include providing a diversion tank into which potentially damaging wastewater can be diverted. This should typically have a capacity of 2 – 3 hours at peak flow rate. The wastewater should be monitored upstream of the treatment plant to allow automatic diversion to the tank. The contents of the diversion tank may be gradually re-introduced into the wastewater stream, or removed for off-site disposal. If you do not provide a diversion tank, you must tell us what equivalent measures you use to protect your treatment plant.

Point source emissions

Basic effluent treatment techniques to be considered as appropriate:

Primary treatment

The objective of this stage is the removal of particulate solids or gross contaminants such as FOG. Typical techniques include screening, equalisation, sedimentation, air flotation and centrifugation. Removing gross contamination reduces the organic loading on the secondary treatment stage, improving performance and reducing the capital and running costs of the plant.

Screens should be the first stage in decreasing the solids loading of the wastewater. Drains and grates in operational areas should be fitted with catchpots.

You should ensure that screening capacity is sufficient to take account of predictable variations in flow rates during day-to-day operation and seasonally.

Settlement is often used to remove particulate and colloidal solids. Some wastewaters (e.g. from citric fruit processing) contain substances that may interfere with settling.

Air flotation may be used when gravity settlement is not appropriate. It is a process in which the suspended solids are chemically treated to form a flocculated structure that can be floated to the surface of a reactor by introducing fine bubbles of air.

Dissolved Air Flotation (DAF) is most widely used because of its effectiveness in removing a range of solids. Other flotation techniques are:

- vacuum flotation
- induced air flotation
- electroflotation.

The choice of chemicals for **coagulation and flocculation** will depend upon the intended disposal route for the DAF sludges

Centrifugation- there are three main types of centrifuge available:

- solid bowl
- basket
- disc-nozzle (this is primarily for liquid/liquid separation).

Secondary treatment

The objective of this stage is the removal of biodegradable materials (BOD). This can be done by degradation or adsorption of pollutants onto the organic sludge produced. Adsorption will also remove non-biodegradable materials such as heavy metals.

There are many treatment systems available. These are either aerobic (BOD is destroyed in the presence of air containing oxygen) or anaerobic (BOD is destroyed in the absence of oxygen).

Point source emissions

The choice of treatment technique is up to you, but you must achieve the benchmark figures in Table 6 (Annex 1) as a minimum standard.

Anaerobic treatment alone is unlikely to achieve a final effluent quality high enough for discharge to a watercourse, and should be followed by aerobic treatment. Also, anaerobic treatment is not suitable for low-strength effluent while aerobic treatment can be used for both high-strength and low-strength effluent.

You should confirm whether ammonia is present after secondary treatment. If it is, you should measure the concentration and, if necessary, use de-nitrification.

In your application you must quote the residence time(s) of effluent in the secondary treatment stage(s), the sludge age and the operating temperature, and show that these are adequate to breakdown the more resistant organic substances.

Solids removal should be provided after a biological plant. This may be by secondary clarifier, but where space permits large, post-treatment lagoons provide excellent protection against bulking and other problems.

Post-treatment lagoons should be designed for easy de-sludging, which should be done regularly.

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

Tertiary treatment

Tertiary treatment refers to any process that is considered a ‘polishing’ phase after secondary treatment, up to and including disinfection and sterilisation systems. It also refers to the recycling of water either as process water or wash water. There are two categories of tertiary treatment process.

Macrofiltration is the removal of suspended solids. Filters may be gravity or pressure filters. The filtration medium may be sand, a mixed medium (e.g. a sand/anthracite blend), or a more specialised medium, such as granular activated carbon (GAC), which is used to remove specific chemicals, tastes and odours.

Membrane techniques are a group of processes that can separate suspended, colloidal and dissolved material from process wastewater. They use a pressure driven semi-permeable membrane to achieve selective separations. Clean water passes through the membrane leaving the impurities behind in a fraction of the feed stream. The clean water (permeate) is

Point source emissions

drawn from the outlet side of the membrane and the residual water containing the concentrated impurities (known variously as concentrate, brine, reject or sludge returns) must be disposed of. You must have a strategy for dealing with the concentrate.

Sludge treatment and disposal

In terms of both capital expenditure and operating costs, sludge treatment and disposal can be as expensive as the rest of the effluent treatment process. Increasing awareness of how waste disposal affects our environment has reduced the options available for disposal and increased the costs, and this trend is likely to continue.

You should also note that the final disposal route chosen will determine the level of treatment required.

Accordingly, you should consider sludge treatment and disposal as early as possible in the design stage.

The disposal of sludge by landspreading may be disrupted by weather conditions. You must consider this when calculating the storage capacity you will need.

You will usually find it easier to reduce the cost of disposal by reducing sludge volume rather than optimising an 'in house' sludge treatment process.

Good primary treatment, where solids are easily removed from the wastewater stream, will reduce sludge volume.

Aerobic biological treatment converts the organic load into bacterial cells that require disposal as sludge. Anaerobic treatment produces less sludge.

Sludge treatment techniques

Sludge treatment techniques are used either to reduce the volume of sludge for disposal, or to change it into a form either suitable for re-use (e.g. landspreading) or for landfill.

Sludge thickening can be used with secondary biological waste sludge and also with primary solids. Primary solids will generally settle and compact without the need for chemical treatment, and the water in them is not strongly held. Secondary treatment sludge, on the other hand, always requires the use of chemical additives to optimise its dewatering.

In order to optimise the dewatering process you should, where possible, blend primary sludge with biological sludge. This minimises the proportion of entrained water.

A conventional sludge thickener (of the gravity/picket fence type) will typically thicken the sludge to 4 – 8% dry solids. For many installations this is sufficient to reduce the volume of sludge to a level that enables cost-effective off-site disposal. For larger sites, the thickening process is preparatory to further dewatering.

Point source emissions Fugitive emissions

Sludge dewatering increases the dry solids content of a sludge, producing a 'solid' waste. This can be 20 – 50% dry solids, which significantly reduces disposal costs.

Dewatering is typically done by adding chemical additives to the sludge and then carrying out one of the following processes:

Filtration using a filter press. This can be manually intensive, and produces a filter cake which is up to 40% dry solids

Filtration using a belt press. This is a continuous process, but requires regular and specialised maintenance and generally has high chemical costs. It produces a filter cake which is up to 35% dry solids

Centrifuging. This is a continuous process that can produce a cake of up to 40% dry solids for certain sludges. Because it is a closed process, odour problems are minimal.

Filtration using a screw press. This is particularly suited to waste with a high proportion of primary screenings, and should produce a cake with 25 – 30% dry solids.

3.2 Fugitive emissions

Fugitive emissions include refrigerants from chilling and freezing equipment as a result of

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

Indicative BAT

You should where appropriate:

1. Regularly inspect pipe joints, shaft seals and gaskets in the refrigeration plant using proprietary leak detection equipment.
2. Ensure that a system log book is kept which records:
    - quantity of refrigerant and oil added to or removed from the system(s)
    - leakage testing results
    - location and details of specific leakage incidents.

Odour Monitoring

3.3 Odour

Odour may arise at various points of the process and should be addressed if it has the potential to cause annoyance. Additional guidance on techniques to deal with odours is provided in the Horizontal Guidance Note H4 Odour – (see GTBR Annex 1)

Indicative BAT

You should as appropriate:

1. Ensure that effluent treatment plant is adequately sized and maintained, and check that site waste water drains do not become blocked. Where present, aeration tanks should be kept aerated and mixed at all times except where maintenance necessitates shut-down of the aeration system. Alternative operational arrangements should be implemented during shut-down to avoid odour nuisance.
2. Design and operate abatement plant to cope with maximum loadings and volumes.
3. Design extraction from odorous activities to minimise air flows to the abatement plant.

3.4 Monitoring

It is good practice to monitor the parameters listed below in Tables 4 A and B as appropriate

Table 4A Monitoring of emissions to controlled water

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

Monitoring

Table 4 B Monitoring of emissions to sewer

Parameter	Monitoring frequency
Flow rate	Continuous and integrated daily flow rate
pH	Continuous
Temperature	Continuous monitoring is appropriate if the temperature of the discharge is above 25°C
COD/BOD	Flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages
TOC	Continuous

4

Annexes

Annex 1-Emission benchmarks

4. Annexes

Annex 1- Emission benchmarks

Emissions to Air

The emissions quoted below are daily averages based upon continuous monitoring during the period of operation.

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

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

Where spot tests are employed:

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

Reference conditions for releases to air

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

- temperature 0 °C (273K);
- pressure 101.3 kPa;
- no correction for water vapour or oxygen.

To convert measured values to reference conditions, see the Monitoring Guidance[1] for more information.

[1] Environment Agency Technical Guidance Notes M1 and M2 provide extensive guidance on the monitoring of stack emissions to air. The conversion referred to is given in TGN M2 (See Annex 1 GTBR)

Annex 1-Emission benchmarks

Table 5 Benchmarks for emissions to air

Parameter	Benchmark (mg/m^3)
Particulates	50 (except where statutory limits e.g. for compliance with the Waste Incineration Directive apply)
VOC (for annual emissions >5 tonne/year)	75

Emissions to Water and Sewer

Where automatic sampling systems are employed, limits may be defined such that not more than 5% of samples shall exceed the limit.

Where spot samples are taken, no individual spot sample in a range of samples shall exceed the limit by more than 50%.

Table 6 Benchmarks for emissions to water or sewer

Parameter	Benchmark (mg/litre)
Biological oxygen demand (5 days, inhibited with allylthiourea [ATU])	10 - 20

Annex 2- Abatement options

Annex 2- Abatement Options

Table 7: Abatement options for specified pollutants

Activity	VOC	Odour	Particulate
Receiving and handling of raw materials (Note 1) (Note 2)			Cy, FF
Preparation of raw materials			
Dry cleaning			Cy, FF
Peeling	C, TO, BO, CO		
Mixing (of dry powders)			Cy, FF
Extrusion	C, TO, BO, CO		
Heat processing using steam or water			
Blanching	C, TO, BO, CO		
Evaporation			Cy, FF
Pasteurisation/sterilisation		Ad, C, TO, BO, CO	
Heat processing using hot air			
Drying	C, TO, BO, CO		Cy, FF
Baking and roasting		Ab, Ad, C, TO, BO, CO	
Frying	Ab, Ad, C, TO, BO, CO		
Grinding and milling			Cy, FF
Solvent extraction	Ad, C, TO, BO, CO		
Effluent treatment systems		Ad, C, TO, BO, CO	

Notes:
1. In addition to enclosure, emissions from conveyor systems should be prevented by minimising freefall distances and reducing velocities.
2. Gravity unloading of, for example, grain from the delivering vehicle to a bunker can give rise to significant dust emissions. Using a technique such as an enclosure or a choke flow system should be employed as appropriate to reduce these emissions.
3. See Table 8 for more information on abatement options.

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

Annex 2- Abatement options

Table 8: Abatement options information

Key	Name	Comment
Ab	Absorption	Suitable for high-flow, low-concentration (1–200 mg/m^3 VOC), low-temperature gas streams, where the pollutant is chemically reactive (or soluble in the case of VOC contaminants). A common use is the treatment of contaminated ventilation air. Water supply and effluent disposal facilities must be available.
Ad	Adsorption	The humid nature of many food waste streams counts against carbon adsorption as a technology because the polar nature of the common adsorbents will preferentially adsorb water vapour.
C	Condensation	Air streams from, for example, cookers and evaporators can contain volumes of water vapour, which are much greater than the volume of air and non-condensables. If the air stream is to be abated by thermal oxidation, the required energy to oxidise a wet stream containing 1 kg water/kg dry air (at 100°C) is approximately 2.6 times the energy requirement for the equivalent dry stream. Condensation is a useful pre-treatment, which, in addition to reducing the fuel requirement and the overall size of oxidiser, will also provide abatement.
TO	Thermal oxidation	For Food and Drink sector applications this will usually require the addition of supplementary fuel to support the combustion process. Even for VOC abatement purposes it is unlikely that any food applications will be autothermal. You can offset the cost of the supplementary fuel when there is a requirement elsewhere on-site for the waste heat that is generated.
BO	Biological oxidation	Typically applied to air streams with VOC < 1500 mg/m^3. Requires a long residence time, typically > 30 s. For a gas flow of 150,000 Nm3/h, a reactor volume of approximately 1250 m^3 would be required. The available surface area may be the limiting factor. Variability in gas flow rate, gas composition in terms of available organic constituents, pH, temperature and humidity may be difficult to manage.
CO	Catalytic oxidation	Suitable for air flow range 150–70,000 m^3/h. The catalyst has an upper temperature limit and an increase in VOC concentration may increase the temperature beyond the limit.
Cy	Cyclones	Relatively cheap and reliable. Not effective against particle sizes <10 um. For example, exhaust from a spray dryer is loaded with dried powder, which is typically passed through a cyclone. The outlet air from the cyclone may contain dust particles up to 200 mg/m^3, which may require additional measures, for example fabric filters.
FF	Fabric filters	Collected dust can be returned to the process or used in animal feed. May not be suitable for some applications. For example, drying baby food has been associated with mould contamination.

Annex 3-Other relevant guidance

Annex 3- Other relevant guidance

For a full list of available Technical Guidance and other relevant guidance see Appendix A of GTBR (see http://publications.environment-agency.gov.uk/pdf/GEHO0908BOTD-e-e.pdf?lang=_e).

In addition to the guidance in GTBR the following guidance is relevant to this sector:

Reference 1 Water efficiency references:

- *Simple measures restrict water costs*, ENVIROWISE, GC22
- *Effluent costs eliminated by water treatment*, ENVIROWISE, GC24
- *Saving money through waste minimisation*: Reducing water use, ENVIROWISE, GG26
- *Optimum use of water for industry and agriculture dependent on direct abstraction: Best practice manual*. R&D technical report W157, Environment Agency (1998), WRc Dissemination Centre, Swindon (tel: 01793 865012)
- *Cost-effective Water Saving Devices and Practices* ENVIROWISE GG067
- *Water and Cost Savings from Improved Process Control* ENVIROWISE GC110
- *Tracking Water Use to Cut Costs* ENVIROWISE GG152

(ENVIROWISE Helpline 0800 585794 *Envirowise website is www. envirowise.gov.uk)*

Annex 3- Other relevant guidance

Reference 2 Releases to water references

- BREF on Waste Water and Waste Gas Treatment. – www.jrc.es/pub/english.cgi/0/733169 or eippcb.jrc.es
- *A4 Effluent Treatment Techniques*, TGN A4, Environment Agency, ISBN 0-11-310127-9 (**EA website**)
- *Cost-effective Separation Technologies for Minimising Wastes and Effluents* ENVIROWISE GG037
- *Cost-effective Membrane Technologies for Minimising: Wastes and Effluents* ENVIROWISE GG044

Reference 3 Main activities and abatement:

- Fellows, P.J, Food Processing Technology Principles and Practice, 2nd Edition, 2000, Woodhead Publishing, ISBN 1 85573 533 4
- Food Processing, November 2000
- ETBPP, Reducing the Cost of Cleaning in the Food and Drink Industry, GG154

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