How to comply with your environmental permit
Additional guidance for:

Dairy and Milk Processing Sector (EPR 6.13)

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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

Introduction

same objective. In cases where the measures are mandatory this is stated.

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, Part A(1):

(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

As well as the main activities described above, the installation will also include directly associated activities which have a direct technical connection with the main activities and which may have an effect on emissions and pollution. These may involve activities such as:

- raw milk reception
- pasteurisation
- cheesemaking
- butter
- yogurt production
- packing
- cleaning
- refrigeration
- the control and abatement systems for emissions to all media
- the combustion plant.

Key issues

The key issues in the dairy sector are:

Accident management

All types of milk, cream and most other dairy products have a very high oxygen demand, and releases into the water environment are serious events. This can happen as a result of spills, process leaks, vessels being overfilled, containment failing, wrong drainage connections and blocked drains.

Introduction

Energy efficiency

The industry is a major energy user. There are significant opportunities to reduce emissions caused by using energy more efficiently and choosing the source of energy wisely (CO_2, SOx, NOx, etc. in particular contribute to global warming and acidification).

Efficient use of raw materials and water

The sector consumes a large amount of water, the vast majority of which is used for cleaning, both manually and in cleaning in place (CIP) systems, which are widely used throughout the industry. Many techniques to minimise water use are also pollution prevention measures relating to effluent management. There are a number of opportunities either to re-use water (for example low-grade wash waters) or to recycle water from, for example, membrane systems (also see Hygiene and food safety).

Avoidance, recovery and disposal of wastes

Commercial considerations mean that process yield and product loss are well 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

Emissions of dust and particulate material can arise from milk powder drying and the transfer of materials. Other emissions include those from refrigeration and effluent treatment systems.

Emissions to water

The composition of effluent within the dairy industry is highly variable, being dependent on the activity, working patterns, product wastage and cleaning systems. The most important way of minimising effluent load is to keep raw materials, intermediates, product and by-product out of the wastewaters, by controlling product wastage and cleaning processes.

Hygiene and food safety

Hygiene and food safety is essential in the dairy 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

1.1 Accident management
1.2 Energy efficiency
1.3 Efficient use of raw materials and water
1.4 Avoidance, recovery and disposal of wastes

Accident management

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.
2. Have instrumentation such as microprocessor control, trips and process interlocks, coupled with independent level, temperature, flow and pressure metering and high or low alarms.
3. Have techniques and procedures in place to prevent overfilling of tanks - liquid or powder- (e.g. level measurement displayed both locally and at the central control point, independent high-level alarms, high-level cut-off, and batch metering).
4. Use measures to detect variation in effluent composition e.g. in-line TOC measurement.
5. Ensure that gross fat, oil and grease (FOG) does not block drains.
6. Identify the major risks associated with the effluent treatment plant (ETP) and have procedures in place to minimise them.
7. Provide adequate effluent buffer storage so that you can stop spills reaching the ETP or controlled water, especially those spills with high organic strength.
8. Protect against spillages and leaks of refrigerants, especially ammonia.

Energy efficiency
Efficient use of raw materials and water

1.2 Energy efficiency

Indicative BAT

You should where appropriate:

1. Use heat recovery from, for example, evaporators, pasteurisers and sterilisers (e.g. the use of regenerative heat exchangers).
2. Use multi-effect evaporators in large scale evaporator applications.
3. Minimise water use e.g. use of recirculating water systems.
4. Use spent cooling water (which is raised in temperature) in order to recover the heat.
5. Schedule production to optimise continuous processing instead of batch.
6. Optimise efficiency measures for combustion plant, e.g. air/feedwater pre-heating, excess air, etc.
7. 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.
8. Achieve the benchmark values set out in Table 1 below:

Table 1

	Energy consumption
Milk	0.07- 0.2 (kWh/l)
Powdered milk	0.3-0.4 (kWh/l)
Ice cream production	0.6-2.8 (kWh/kg)

1.3 Efficient use of raw materials and water

Membrane technology produces a high quality permeate suitable for re-use 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. Potable water can be generated by removing soluble substances with membrane technology (in-line biological treatment or evaporation techniques could also be used).

Efficient use of raw materials and water

Indicative BAT

You should where appropriate:

1. Interlock chemical dosing pumps with cleaning operations, in order to prevent continued dosing after cessation of cleaning.
2. Identify and evaluate how you can recycle or reuse water, taking into consideration hygiene issues. The best 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)
   - recycling following treatment.
3. Assess the application of membrane techniques for use in each unit process as well as for the final effluent stream.
4. Use contaminated condensate for lower grade cleaning activities e.g. yard washing
5. Optimise the CIP system to reduce water use. (Refer to operating techniques.)
6. Achieve the benchmark values set out in Table 2 below:

Table 2

	Water consumption
Milk	0.6-1.8 (l/l)
Powdered milk	0.8-1.7(l/l)
Ice cream production	4.0 -6.5 (l/kg)

Avoidance, recovery and disposal of wastes

1.4 Avoidance, recovery and disposal of wastes

Two coefficients are commonly used to measure milk loss and water usage:

- %COD (or milk) loss to effluent (measured as COD)
- effluent:milk intake ratio (or water:milk intake ratio)

To calculate the %COD loss to effluent, the procedure is to use effluent loadings and compare this against the milk intake, converted to kgCOD, as follows:

$$\%\text{COD loss} = \frac{\text{Effluent Load, kgCOD}}{\text{Milk Intake, as kgCOD}} \times 100$$

To do this we usually consider the COD equivalent of milk as 220 kgCOD/m^3, or 220,000 mg/l, although this can vary depending on butterfat content, SNF ratios, etc.

The effluent:milk ratio (or water:milk ratio) is simply a ratio between the amount of effluent or water used compared against milk or product intake. Again, this allows for comparison across similar processing sites.

For simple milk processing sites a 1.5% milk loss to effluent and approximately 1.5:1 effluent:milk ratio would be acceptable but some sites with excellent wastage management can (and do) achieve less than 1% milk loss to effluent and an effluent:milk ratio of 1:1, or less.

Using these measures as part of the wastage monitoring for the site will allow you to set targets and track progress as part of your waste 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
- operator awareness
- measurement of losses
- constraints on the effluent disposal route
- process design of the CIP systems
- plant utilisation efficiency and downtime.

Envirowise provide some useful examples. (See reference in GTBR)

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. Measures, which should be implemented as appropriate, include those in table 3 below:

Avoidance, recovery and disposal of wastes

Table 3: Process monitoring and control

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	Waste from material damaged by shear friction forces minimised
Level measurement	Storage and processing vessels	Prevents overflow from storage or processing tanks
Flow measurement	Transfer lines	Accurate addition of materials to processing vessels minimises excessive use of materials and formation of out of spec products
	Steam supply	Maintains correct operating temperature and minimises 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

Avoidance, recovery and disposal of wastes

Indicative BAT

You should where appropriate:

1. Use the two coefficients "%COD (or milk) loss to effluent" (measured as COD) and "effluent:Milk Intake Ratio" (or Water:Milk Intake Ratio), to set targets and track progress as part of your waste control campaign.
2. Set up effluent monitoring to provide baseline information on wastewater loadings (kgCOD and volume) and the loss coefficients mentioned above. You should set yourself a target effluent to milk ratio of 1:1 or less.
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.
   - 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.
4. Continue monitoring and review your performance regularly.
5. Carry out any appropriate measurements listed in Table 3 above.
6. Consider whether your packing line efficiency can be improved.

2

Operations

2.1 Pasteurisation, sterilisation and UHT
2.2 Evaporation
2.3 Drying
2.4 Centrifugation and bactofugation
2.5 Churning
2.6 Cooling, chilling and freezing
2.7 Forming, moulding and extrusion
2.8 Filling
2.9 Fermentation/incubation process
2.10 Cleaning and sanitation

Pasteurisation, sterilisation and UHT
Evaporation

2. Operations

2.1 Pasteurisation, sterilisation and UHT

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.

2.2 Evaporation

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.)

Drying
Centrifugation and bactofugation

2.3 Drying

The main issues are

- emissions to air - typically exhaust air is passed through cyclones. (Note that the outlet air of cyclones may contain dust particles up to 200 mg/m^3 which will require secondary abatement *e.g.* fabric filters)
- odour
- energy efficiency

Indicative BAT

1. You should where appropriate to reduce heat losses and save energy from your drying systems:

- recirculate exhaust air to heat the inlet air
- use direct flame heating by natural gas and low NOx burners
- use two stage drying (*e.g.* spray drying followed by fluidised bed)
- pre concentrate the product using multiple effect evaporation.

2.4 Centrifugation and bactofugation

Centrifuges need to desludge solid material that builds up in the separating disks to maintain performance and milk quality. This “separator desludge” has a very high COD (c.100,000 mg/l). It often accounts for around 10 to 20% of the dairy factory total effluent loading, and is suitable for collection for separate disposal rather than discharge to effluent.

Churning
Cooling,chilling and freezing
Forming, moulding and extrusion

2.5 Churning

Due to its high fat content (c.80%), butter has a very high COD (c.>2,400,000mg/l), and even buttermilk has a COD of around 100,000mg/l, so care has to be taken to avoid loss to effluent. Modern cleaning techniques use steam to melt out the residual butter prior to cleaning. This melt-out is then used during the next production run. Effluent streams from buttermaking dairies may contain high levels of fats, oils and greases (FOG).

Indicative BAT

You should where appropriate:

1. Evaluate effluent treatment and disposal options to take account of high COD and FOG from churning.
2. Rework meltout collected from cleaning operations.

2.6 Cooling, chilling and freezing

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. Apply energy efficient techniques (see energy efficiency section above).

2.7 Forming, moulding and extrusion

Whey released from cheese moulds and presses has a very high COD (approximately 60 to 80 000mg/l) and this requires collection rather than disposal to effluent. Some solid waste may be generated due to loss of product at the start and finish of the production process. Spillage of whey should be guarded against as it could seriously overload effluent treatment systems.

Filling
Fermentation/incubation process

2.8 Filling

Before installing a new filling system you should consider the water requirements of the machine (both in use and during cleaning) along with any systems for the separate collection of high strength purges or interfaces that are produced during start-up and shut-down. Some high-speed fillers (especially with glass bottles) are noisy and require abatement measures to be adopted.

Indicative BAT

You should where appropriate:

1. Optimise filling line speed to reduce volume of reclaimed milk due to carryover when changing product on a filling line.

2.9 Fermentation/incubation process

The cultured milk product produced in fermentation reactions is often a viscous, sometimes semi-solid material, with a high COD content (c.200 to 400,000mg/l), so any spillages to effluent can have an impact on effluent treatment processes.

Some solid waste may be generated due to loss of product at the start and finish of the production process.

Indicative BAT

You should where appropriate:

1. Avoid off specification product by maintaining a very high standard of hygiene and cleanliness.

Cleaning and sanitation

2.10 Cleaning and sanitation

CIP systems can be much more efficient than manual cleaning but should be designed and used with due consideration to wastewater minimisation, since experience shows that CIP systems use much more water than manual cleaning techniques. In modern, large-scale dairy plants about half of all the effluent loading (both volumetric and organic, kgCOD) from the factory comes from CIP operations, so it pays to ensure that these systems are fully optimised with regard to water usage and product loss.

On most CIP cleans, the pre-rinse stage of the sequence contains the most product loss, so this can be examined in detail to build a picture of product wastage from each CIP pre-rinse operation. Samples of the pre-rinse can be taken every 5-15 seconds and analysed. You can use this data to optimise CIP programmes and ensure minimal losses and efficient cleaning.

Careful examination of CIP sequences can give substantial savings in product loss (and hence environmental impact) and water usage.

The exact design of a CIP system is determined by a variety of factors, including:

- how many individual CIP circuits are to be served by each CIP station?
- how many require hot rinses and how many require cold rinses?
- are the initial milk/product rinses collected?
- will they be processed (evaporated), or collected for animal feed?
- what method of disinfection will be used? Chemicals, steam or hot water?
- what is the estimated product loss, steam, and water demand of each cleaning operation?

Cleaning and sanitation may have the following environmental impact:

Water: Wash waters will contain remnants of cleaning agents, product rinsed from the system and removed from the equipment that is cleaned.

Energy: Cleaning is commonly carried out at elevated temperatures utilising steam. Pre-clean systems, for example vacuum transfer, blowers and pigging systems, require power and compressed air.

Accidents: Spillage of cleaning chemicals. Leakage from effluent system. Overloading of effluent treatment system.

Cleaning and sanitation

Indicative BAT

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

1. Equipment design:
   - modifying process lines and operations wherever practicable to eliminate or reduce excessive spillage of material onto the floor
   - removing as much residual material as possible from vessels and equipment before they are washed
   - ensuring that drains are equipped with catchpots
   - ensuring that the catchpots are in place during cleaning (for example by installing lockable catchpots)
   - optimising the water pressure at jets, nozzles and orifices
   - using an automatic water supply shut off on trigger operated spray guns or hoses.
2. Good housekeeping:
   - installing trays to collect waste to prevent it falling to the floor
   - sweeping, shovelling or vacuuming spilt material rather than hosing it down the drain
   - making sure suitable dry clean-up equipment is always readily available
   - providing convenient, secure receptacles for the collected waste
   - optimising cleaning schedules
   - matching cleaning cycle durations to the vessel size
   - product scheduling to minimise numbers of product changes and subsequently cleaning between products.
3. Management of manual cleaning:
   - using procedures to ensure that hoses are only used after dry clean-up
   - using trigger controls on hand-held hoses and water lances to minimise the use of washdown water
   - using high-pressure/low-volume systems.

Cleaning and sanitation

4. Cleaning chemicals usage:
    - ensuring that staff (and contract cleaners) are trained in the handling, making up and application of working solutions, for example, not setting the concentration of the chemical agent too high and avoiding the overuse of chemicals, particularly where manual dosing is used.
5. Cleaning-in-place (CIP):
    - removing product before the start of the wash cycle by gravity draining, pigging or air blowdown
    - pre-rinsing to enable remaining product to be recovered for re-use or disposal
    - using in-line turbidity or conductivity detectors to isolate product/water interface and maximise product recovery
        - for example conductivity sensors can be used to monitor levels of dissolved salts. This enables the automatic detection of milk:water interfaces so that product may be recovered for re-processing
        - turbidity sensors can also be used to monitor the quality of process water and CIP systems and will therefore minimise effluent from out-of-specification products/process water and optimise re-use of cleaning water respectively.
    - optimising the 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
    - setting the recycle control on conductivity rather than time
    - continuous cleaning of recirculated solutions
    - using water-efficient spray devices.
6. Sanitisation
    - you should justify the use of organohalogen-based oxidising biocides over the alternatives, for example ozone and UV light.
7. Recycling of water and recovery of cleaning chemicals.
8. Using dry clean-up techniques to reduce wastewater strength.

3

Emissions and monitoring

3.1 Emissions to water

3.2 Monitoring

Emissions to water

3. Emissions and monitoring

3.1 Emissions to water

A wide variety of techniques is available for the control of releases to water or sewer, and the BREF on Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector should be consulted. Section 3.3 of the BREF has details of available water treatment techniques and Section 4.3.1 contains recommendations on what might constitute BAT for a variety of treatment techniques for releases to water.

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.

Substantial reductions in the volume of wastewater generated in 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, effluent may contain some substances that may have an adverse effect on treatment plants or receiving waters. These include:

- salinity where large amounts of salt are used (e.g. 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. The COD of the main dairy products are shown in the table below:

Dairy Product	COD mg/l
Whole milk	220, 000
Semi-skimmed milk	185, 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 yoghurt (average)	c. 350, 000
Butter	2, 430, 000

Emissions to water

Whilst relatively high levels are inevitable in many cases, preventing milk and milk products from unnecessarily entering the wastewater system and optimising chemical use can make a significant difference. Suspended solids concentrations in dairy processing wastewaters also vary depending on processing options used within the factory. Wastewater from the dairy sector may 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 error can result in excessively high or low pH that causes problems for wastewater treatment.

The presence of pathogenic organisms in the wastewater may be a consideration.

In addition to the various BREFs (See GTBR and Reference 2) and the techniques below, guidance on cost-effective effluent treatment techniques can be found in water efficiency references (Annex 2).

Indicative BAT

You should where appropriate:

1. Keep raw materials and product out of the wastewater system wherever possible.
2. Use reverse osmosis techniques to process 'whitewater' (waste milk flushed from the system during cleaning).
3. 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 biological oxygen demand (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.

Emissions to water

4. 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.

Basic effluent treatment techniques

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. The choice of chemicals for coagulation and flocculation will depend upon the intended disposal route for the DAF sludges. Other flotation techniques are

- Vacuum flotation
- Induced air flotation
- Electroflotation

Centrifuges. There are three main types available:
- Solid bowl
- Basket
- Disc-nozzle (this is primarily for liquid/liquid separation)

Emissions to water

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). The choice of treatment technique is up to you, but you must achieve the benchmark figures in 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.

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 drawn from the outlet side of the membrane and the residual water containing the concentrated impurities

Emissions to water

(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.

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:

Emissions to water

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.

Monitoring

3.2 Monitoring

Indicative BAT

It is good practice to monitor the parameters listed in Table 4 (if you emit to controlled water) or Table 5 (if you emit to sewer)

Table 4 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

Table 5 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

Annex 2 Other relevant guidance, abbreviations and glossary

Annex 1-Emission benchmarks Annex 2- Other relevant guidance, abbreviations and glossary

4. Annexes

Annex 1- Emission benchmarks

Emissions to water

Emission	Benchmark value	Basis for the benchmark
BOD	10 – 20 mg/l	On-site biological treatment can achieve this quality

Emissions to air

Emission	Benchmark value	Basis for the benchmark
Particulates	50 mg/m^3	

Annex 2- Other relevant guidance, abbreviations and glossary

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

Annex 2- Other relevant guidance, abbreviations and glossary

- *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)*

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

Abbreviations and glossary

Abatement Plant	Equipment used to remove polluting substances from a discharge to air or water
BOD	Biological Oxygen Demand. This is the amount of oxygen required by biological organisms to deal with the organic substances in a discharge to water. It is a measure of the potential of the discharge to harm the ecosystem of the receiving water.
COD	Chemical Oxygen Demand. This is the amount of oxygen required to chemically destroy the organic substances in a discharge to water. It is a measure of the potential of the discharge to harm the ecosystem of the receiving water.
DAF	Dissolved Air Flotation. This is a process in which suspended

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