BAT Guidance Note on Best Available Techniques for the Production of Cement and for the Production of Lime in a Kiln

(1st Edition)

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1. INTRODUCTION

1.1 GENERAL

This Guidance Note is one of a series issued by the Environmental Protection Agency (EPA) which provide guidance on the determination of Best Available Techniques (BAT) in relation to:

- applicants seeking Integrated Pollution Prevention and Control (IPPC) licenses under Part IV of the Environmental Protection Agency Acts 1992 to 2007,
- existing Integrated Pollution Prevention and Control (IPPC) Licensees, whose licence is to be reviewed under the Environmental Protection Agency Acts 1992 to 2007,
- applicants seeking Waste Licenses under Part V of the Waste Management Acts 1996 to 2008,
- existing Waste Licensees, whose licence is to be reviewed under the Waste Management Acts 1996 to 2008.

This Guidance Note shall not be construed as negating the installation/facility statutory obligations or requirements under any other enactments or regulations.

1.2 BAT GUIDANCE NOTE STRUCTURE

This Guidance Note has been structured as follows:

Section	Details
1	Introduction
2	Interpretation of BAT
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Where relevant, references are made to other detailed guidance; such as the reference documents (BREF) published by the European Commission, Agency Guidance Notes for *Noise in Relation to Scheduled Activities*, and the determination of BAT should be made giving regard to these.

The information contained in this Guidance Note is intended for use as a tool to assist in determining BAT for the specified activities.

2. INTERPRETATION OF BAT

2.1 STATUS OF THIS GUIDANCE NOTE

This Guidance Note will be periodically reviewed and updated as required to reflect any changes in legislation and in order to incorporate advances as they arise.

Techniques identified in these Guidance Notes are considered to be current best practice at the time of writing. The EPA encourages the development and introduction of new and innovative technologies and techniques, which meet BAT criteria and look for continuous improvement in the overall environmental performance of the sectors activities as part of sustainable development.

2.2 INTERPRETATION OF BAT

BAT was introduced as a key principle in the IPPC Directive, 96/61/EC. This Directive has been incorporated into Irish law by the Protection of the Environment Act 2003. To meet the requirements of this Directive, relevant Sections of the Environmental Protection Agency Act 1992 and the Waste Management Act 1996 have been amended to replace BATNEEC (Best Available Technology Not Entailing Excessive Costs) with BAT.

Best available techniques (BAT) is defined in Section 5 of the Environmental Protection Agency Acts, 1992 to 2007, and Section 5(2) of the Waste Management Acts 1996 to 2008 as the “most effective and advanced stage in the development of an activity and its methods of operation, which indicate the practical suitability of particular techniques for providing, in principle, the basis for emission values designed to prevent or eliminate or where that is not practicable, generally to reduce an emission and its impacts on the environment as a whole” where:

B ***‘best’*** in relation to techniques, means the most effective in achieving a high general level of protection of the environment as a whole,

A ***‘available techniques’*** means those techniques developed on a scale which allows implementation in the relevant class of activity under economically the technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced within the State, as long as they are reasonably accessible to the person carrying out the activity,

T ***‘techniques’*** includes both the technology used and the way in which the installation is designed, built, managed, maintained, operated and decommissioned.

The range of BAT associated emission level values specified in Section 6 indicate those that are achievable through the use of a combination of the process techniques and abatement technologies specified as BAT in Section 5. The licensee must demonstrate to the satisfaction of the Agency, during the licensing process, that the installation/facility will be operated in such a way that all the appropriate preventative measures are taken against pollution through the application of BAT and justify the application of other than the most stringent ELV in the range.

At the installation/facility level, the most appropriate techniques will depend on local factors. A local assessment of the costs and benefits of the available options may be needed to establish the best option. The choice may be justified on:

- the technical characteristics of the installation/facility;
- Its geographical location;
- Local environmental considerations;

- The economic and technical viability of upgrading existing installations.

The overall objective of ensuring a high level of protection for the environment as a whole will often involve making trade-off judgments between different types of environmental impacts, and these judgments will often be influenced by local considerations. On the other hand, the obligation to ensure a high level of environmental protection including the minimisation of long-distance or transboundary pollution implies that the most appropriate techniques cannot be set on the basis of purely local considerations.

The guidance issued in this Note in respect of the use of any technology, technique or standard does not preclude the use of any other similar technology, technique or standard that may achieve the required emission standards.

2.3 BAT HIERARCHY

In the identification of BAT, emphasis is placed on pollution prevention techniques rather than end-of-pipe treatment.

The IPPC Directive 96/61/EC and the Environmental Protection Agency Acts 1992 to 2007 (Section 5(3)), require the determination of BAT to consider in particular the following, giving regard to the likely costs and advantages of measures and to the principles of precaution and prevention:

(i) the use of low-waste technology,

(ii) the use of less hazardous substances,

(iii) the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate,

(iv) comparable processes, facilities or methods of operation, which have been tried with success on an industrial scale,

(v) technological advances and changes in scientific knowledge and understanding,

(vi) the nature, effects and volume of the emissions concerned,

(vii) the commissioning dates for new or existing activities,

(viii) the length of time needed to introduce the best available techniques,

(ix) the consumption and nature of raw materials (including water) used in the process and their energy efficiency,

(x) the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it,

(xi) the need to prevent accidents and to minimise the consequences for the environment, and

(xii) the information published by the Commission of the European Communities pursuant to any exchange of information between Member States and the industries concerned on best available techniques, associated monitoring, and developments in them, or by international organisations, and such other matters as may be prescribed.

3. SECTORS COVERED BY THIS GUIDANCE NOTE

This Guidance Note covers the following activities under the First Schedule of the Environmental Protection Agency Acts 1992 to 2007:

10.1	The production of cement.
13.3	The production of lime in a kiln.

The Guidance Note is split into two parts to deal with each sector:

Part A	The production of cement.
Part B	The production of lime in a kiln.

It should be noted that quarrying aspects of raw material production are outside the scope of this Guidance Note. In addition, the use of wastes as alternative fuels (co-incineration) is excluded from the scope of this Guidance Note.

4 PROCESS DESCRIPTION, RISK TO THE ENVIRONMENT AND CONTROL TECHNIQUES – PART A: CEMENT MANUFACTURE

(Note: any reference to BREF in this document means the reference document on Best Available Techniques in the Cement and Lime Manufacturing Industries, published by the European Commission, December 2001).

4.1 DESCRIPTION OF PROCESS

All cement manufacturing processes have the following processing steps in common:

- Raw material delivery, storage and preparation (see BREF Section 1.2.2)
- Fuel delivery, storage and preparation (see BREF Section 1.2.3)
- Clinker burning (see BREF Section 1.2.4)
- Cement grinding and storage (see BREF Section 1.2.5)
- Packing and dispatch (see BREF Section 1.2.6).

The major process step is the conversion of raw materials into cement clinker. There are four main types of process involved; the dry, semi-dry, semi-wet and wet processes. See BREF section 1.2 for a description of each of these process types. All cement manufacturing processes in Ireland that are in operation at present are dry processes.

4.2 RISK TO THE ENVIRONMENT

The key environmental issues for the manufacture of cement are energy use and emissions to air. The key emissions to air are nitrogen oxides (NO_x), sulphur dioxide (SO_2) and dust. Clinker burning in the cement kiln is the most significant part of the process in terms of these key environmental issues.

In cement manufacture, CO_2 is generated from the combustion of fuel as well as from the liberation of CO_2 during the conversion the raw materials ($CaCO_3$ conversion to CaO).

Other emissions, the effects of which are normally slight or localised, are noise and odour.

4.2.1 Emissions to Air

Nitrogen compounds are emitted from the cement kiln and are associated with fuel and combustion air (see BREF Section 1.3.3.1).

Sulphur compounds can be emitted from the cement kiln and arise from sulphur in fuel and raw materials. Sulphur emissions from cement kilns result primarily from the content of the volatile sulphur in raw materials. Sulphur in fuels fed to preheater kilns will not necessarily lead to significant sulphur emissions due to the strong alkaline nature in the sintering zone, the calcinations zone and in the lower stage of the preheater (see BREF Section 1.3.3.2).

Dust arises from a number of sources, principally cement kilns, raw mills, clinker coolers, and cement mills. Fugitive dust emission sources mainly arise from storage and handling of materials, and from vehicle traffic at the site (see BREF Section 1.3.3.3).

Other emissions to air from cement manufacture can include carbon monoxide (CO) (see BREF Section 1.3.3.4), volatile organic compounds (VOCs) (see BREF Section 1.3.3.5), dioxins and furans (see BREF Section 1.3.3.6), metals and their compounds (see BREF Section 1.3.3.7), hydrogen fluoride (HF), and hydrogen chloride (HCl).

4.2.2 Emissions to Water

There is no process wastewater directly associated with the manufacture of cement. Emissions mainly arise from surface water run-off and cooling water. The storage and handling of fuel is a potential source of contamination of soil and groundwater.

4.2.3 Waste

Waste can include dust from abatement systems and kiln bypass that is not reusable; sludges from surface water interceptors and settlement tanks; and unusable material generated during raw meal preparation (see BREF Section 1.3.4).

4.2.4 Noise

The heavy machinery used in cement manufacture can give rise to emissions of noise and/or vibration.

4.3 CONTROL TECHNIQUES

The existing or possible measures for eliminating, reducing and controlling emissions in cement manufacture are described in this section.

4.3.1 General Preventative Techniques

4.3.1.1 Process Selection

The type of process selected will have an effect on releases of all pollutant types and will also have a significant effect on energy use (see BREF Section 1.4.3).

4.3.1.2 Use of Energy

In terms of cement manufacturing, the energy efficient techniques described in BREF chapter 1.4.2, and the process optimisation techniques (see BREF Section 1.4.4.1) should be considered.

4.3.1.3 Raw Materials

Reuse of collected dust directly in the process or by blending with finished cement products (see BREF Section 1.4.9). It may be possible to replace certain virgin raw materials with material generated in other industries (see BREF Section 1.2.1).

4.3.2 Techniques for the Prevention and Minimisation of Emissions

4.3.2.1 Stable Kiln Operation

Maintaining a stable kiln operation will reduce the overall level of emissions due to process upsets, start ups and shutdowns (see BREF Section 1.4.4.1).

4.3.2.2 Choice of Fuel and Raw Materials

Careful fuel and raw material selection, in conjunction with sufficient control of substances entering the kiln can reduce emissions. Limiting the nitrogen, metals, chlorine and organic compound content of raw materials and fuels can reduce emissions (see BREF Section 1.4.4.2).

4.3.3 Specific Techniques for NOx Emissions

Techniques can be used to prevent or minimise the formation of NOx in the first place, or to treat or abate NOx after it has formed. These techniques are described below and are also summarised in BREF Section 1.4.5.

4.3.3.1 Minimisation of NOx Formation

Techniques for minimising NO_x formation are:

- **Primary measures** including:
  - **Flame cooling** through addition of water to the fuel or directly to the flame (see BREF Section 1.4.5.1).
  - **Low-NO_x burner** (see BREF Section 1.4.5.1).
  - Other **general primary optimisation measures**, such as process control measures, improved firing technique, optimised cooler connections, maintaining a consistent raw mix, a consistent fineness of grind for solid fuels, and fuel selection.
- **Staged combustion**. Usually in the form of precalciners. Reduces NO_x formation by creating a reducing atmosphere at each of the combustion stages which favours the conversion of NO_x back into elementary nitrogen (see BREF Section 1.4.5.2).
- **Mid-kiln firing.** In long dry kilns the creation of a reducing zone by firing lump fuel can reduce NO_x emissions where alternative fuels are used (see BREF Section 1.4.5.3).
- **Mineralised clinker**. Produced by adding mineralisers (such as calcium fluoride) to the raw material. Adjusts clinker quality and allows the sintering zone temperature to be reduced. A lower temperature results in reduced NO_x formation (see BREF Section 1.4.5.4).

4.3.3.2 Abatement of NOx Emissions

Techniques for abating NO_x emissions are:

- **Selective non-catalytic reduction (SNCR).** Involves injecting ammonia based compounds into the exhaust gas to reduce NO_x to N_2 (see BREF Section 1.4.5.5).
- **Selective catalytic reduction (SCR).** Operates similar to SNCR in that ammonia is used to reduce NO_x to N_2, assisted by a catalyst allowing a lower temperature range compared to SNCR (see BREF Section 1.4.5.6).

4.3.4 Specific Techniques for SO_2 Emissions

Measures that control SO_2 emissions can be broken down into those that reduce the formation of SO_2 in the first place, those that remove SO_2 from the gases and incorporate the sulphur into the clinker product, and those that remove SO_2 by abatement or end of pipe. These techniques are described below and are also summarised in BREF Section 1.4.6.

4.3.4.1 Minimisation of SO_2 Formation

Techniques for minimising SO_2 formation are:

- **Choice of process**. Sulphur in the fuels fed to preheater kilns will not lead to significant SO_2 emissions, whereas in long kilns it can lead to significant SO_2 emissions (see BREF Section 1.3.3.2).
- **Primary measures** to reduce SO_2 formation, including:
- **Choice of raw materials and fuels** – minimise sulphur content as much as possible.
- **Optimisation of kiln operation and maintaining stable kiln conditions.** See process optimisation techniques (see BREF Section 1.4.4.1).
- **Choice of oxygen concentration.** A balance to protect the environment should be sought by optimising $NOx/SO_2/CO$ levels by adjusting the backend oxygen content (see BREF Section 1.4.6).
- **SO_2 absorption by raw mill** and incorporation into product (see BREF Section 1.3.3.2).
- **Absorbent addition**. Absorbents (e.g. slaked lime, quicklime) added to kiln feed or to exhaust gases from kiln preheater. Absorbent reacts with the SO_2 and is incorporated into the clinker (see BREF Section 1.4.6.1).
- **Dry scrubber.** Also utilises absorbent addition and incorporation into product, but the absorbent is contained in a separate column (see BREF Section 1.4.6.2).
- **Wet scrubber.** A spray tower where an absorbent slurry spray absorbs SO_2, then is separated and used as gypsum in cement milling (see BREF Section 1.4.6.3).
- **Activated carbon**. Can be used to remove a variety of pollutants such as SO_2, organic compounds, metals, NH_3 & NH_4 compounds, HCl, HF and residual dust. It is usually only considered where alterative fuels with significant organic and other pollutant content are in use (see BREF Section 1.4.6.4).

4.3.5 Specific Techniques for Dust Emissions

4.3.5.1 *Minimisation of Dust Emissions*

Techniques for minimising dust emissions:

- **Process** dust emissions can be minimised through using cyclones prior to dust abatement equipment. Cyclones are often, but not always, an integral part of cement process equipment.
- **Fugitive** dust emissions can be minimised through a simple and linear site layout, paved roads, closed storage with automatic handling, enclosed conveyors for dusty materials/fines, a minimum number of conveyor transfer points, and good housekeeping (see BREF Section 1.4.7.3). Other techniques such as the use of automatic devices and control systems, minimising process upsets, and preventive maintenance will also help prevent fugitive dust emissions.

4.3.5.2 *Abatement of Dust Emissions*

Techniques for abating dust emissions (see BREF Section 1.4.7) and include:

- **Electrostatic precipitators (ESPs)** (see BREF Section 1.4.7.1 for a description of ESPs and for techniques to enhance existing ESPs, such as use of voltage reduction rather than complete system CO trips and see BREF Section 1.4.4.1 for process control optimisation in relation to ESPs and CO trips)
- **Fabric filters** (see BREF Section 1.4.7.2)
- Techniques for **fugitive dust abatement** include ventilation and collection in fabric filters, mobile and stationary vacuum cleaning, open pile and conveyor wind

protection, road wetting, and water spray and chemical dust suppressors (see BREF Section1.4.7.3).

4.3.6 Other Emissions

Techniques to control other emissions, including:

- CO_2 and CO emissions, all measures that reduce fuel energy use also reduce associated CO_2 emissions (see BREF Section 1.4.8.1)
- VOC, dioxin and furan formation (see BREF Section 1.4.8.2)
- metal emissions (see BREF Section 1.4.8.3)
- odour formation (see BREF Section 1.4.11)
- overall emissions per tonne of cement product - reduce the quantity of cement clinker in the final cement product by replacing with other main constituents.

4.3.7 Techniques for Recovery and Recycling of Wastes

Collected dust can be recovered and reused in the cement production process. Alternative uses may be found for material that cannot be reused in the process due to its composition (see BREF Section 1.4.9). Alternative uses include lightweight construction aggregates and blocks and for soil stabilisation in civil engineering projects.

4.3.8 Techniques for Treating Water Emissions

Contamination of wastewater should be minimised as much as possible through appropriate site layout and design of surface water collection systems, keeping uncontaminated water separate from contaminated water, and good housekeeping measures to minimise the likelihood of contamination by particulates.

Wastewater emissions should be minimised by recycling and re-use wherever practicable. The use of lower quality water may be possible for some applications rather than fresh water (dust suppression, wheel washing, etc.).

Treatment of contaminated water may involve:

- pH correction/neutralisation
- coagulation/flocculation/precipitation
- sedimentation/filtration/flotation
- oil/water separator.

4.3.9 Techniques for Appropriate Disposal of Wastes

After all options for the reduction, recovery, reuse and recycling of wastes have been exhausted, appropriate treatment and disposal of such wastes should be carried out. These include:

- Sludge dewatering.
- Landfill of wastes in an appropriate licensed facility.

4.3.10 Noise

For guidance on measures in relation to noise, have regard to the Guidance Note for Noise in relation to scheduled activities.

5. BEST AVAILABLE TECHNIQUES FOR THE CEMENT INDUSTRY

5.1 INTRODUCTION

As explained in Section 2, this Guidance Note identifies BAT but obviously does so in the absence of site-specific information. Accordingly, it represents the requirements expected of any new activity covered by the Note, and ultimately the requirement expected of existing facilities, but exclude additional requirements, which may form part of the granting of a licence for a specific site.

The technical feasibility of the measures listed below has been demonstrated by various sources. Used singly, or in combination, the measures represent BAT solutions when implemented in the appropriate circumstances. These circumstances depend on plant scale, process type, etc.

5.2 BAT FOR THE CEMENT INDUSTRY

5.2.1 Process Selection

For new plants and major upgrades BAT for the production of cement clinker is considered to be a dry process kiln with multi-stage preheating and precalcination. The associated BAT heat balance value is 3,000 MJ/tonne clinker with a 5 cyclone stage preheater system. This value will increase for lower numbers of stages and will vary depending on raw materials and fuel used.

5.2.2 General Primary Measures

BAT for the manufacture of cement includes the following general primary measures:

- A smooth and stable kiln process, operating close to the process parameter set points. This can be obtained by applying:
- Process control optimisation, including computer-based automatic control systems.
- The use of modern, gravimetric solid fuel feed systems.
- Minimising fuel energy use by means of:
  - Preheating and precalcination to the extent possible, considering the existing kiln system configuration.
  - The use of modern clinker coolers, where coolers are to be replace, enabling maximum heat recovery.
  - Heat recovery from waste gases.
  - Following the BAT Guidance Note on Energy Use.
  - Careful selection and control of substances entering the kiln.
    - Where practicable, selection of raw materials and fuels with low sulphur, nitrogen, chlorine, metals and volatile organic compound content.

5.2.3 Nitrogen Oxides

BAT for reducing NO_X emissions is the combination of the above described general primary measures and:

- Flame cooling
- Low-NO_X burner
- Staged combustions
- Mineralised clinker
- Selective non-catalytic reduction (SNCR).

5.2.4 Sulphur Dioxide

BAT for reducing SO_2 emissions are the combination of the above described general primary measures and:

- For initial emission levels not higher than approximately 1,200 mg SO_2/m^3
  - Raw mill absorption, and, if necessary
  - Absorbent addition.
- For initial emission levels higher than approximately 1,200 mg SO_2/m^3
  - Raw mill absorption, and
  - Wet scrubber, or
  - Dry scrubber.

5.2.5 Dust

BAT for reducing dust emissions are the combination of the above described general primary measures and:

Minimisation of particulate matter from point sources by application of:

- Cyclones

Efficient removal of particulate matter from point sources by application of:

- Electrostatic precipitators with fast measuring and control equipment to minimise the number of CO trips.
- Fabric filters with multiple compartments and burst bag detectors.

Minimisation/prevention of dust emissions from fugitive sources as described in Chapter 4.3.5.1, and where this is not possible/practicable,

- Abatement of dust emissions from fugitive sources as described in Chapter 4.3.5.2.

5.2.6 Waste Water

Effluent should be minimised by recycling and re-use wherever practicable. Cooling water, storm water, bund water and effluents of different origin may be separated in order to permit appropriate treatment/recycling options. The use of lower quality water may be possible for some parts of the process rather than fresh water (dust suppression).

5.2.7 Waste

The recovery and reuse of collected particulate matter in the process is considered BAT. Where the collected dusts are not reusable due to chemical composition the utilisation of these dusts in other commercial products, where possible, is considered BAT.

Further information on a number of waste gas and wastewater treatment techniques can be found in the BREF document on Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector, EIPPCB, February 2003.

6. BAT ASSOCIATED EMISSION LEVELS

6.1 EMISSION LEVELS FOR DISCHARGES TO AIR

The BAT associated emission levels for discharges to air are as set out in the following tables:

Table 6.1.1 The BAT-associated emission levels for emissions to air for NO_x

	Emission Levels mg/m^3 (as NO_2 on a daily average basis)
Facilities where SNCR is BAT	200 – 500
New facilities where SNCR is not BAT	500 - 800
Existing facilities where SNCR is not BAT	500 – 1,800

Table 6.1.2 The BAT-associated emission levels for emissions to air for SO_2

	Emission Levels mg/m^3 (as SO_2 on a daily average basis)
New facilities	200 - 400
Existing facilities	200 - 750

Table 6.1.3 The BAT-associated emission levels for emissions to air for particulates

		Emission Levels mg/m^3 (on a daily average basis)
New facilities		20 - 30
Existing facilities:	Kiln/milling/drying > 500 kt/annum plant clinker capacity < 500 kt/annum plant clinker capacity	20 - 50 20 - 100
	Clinker cooling	20 - 100
	Clinker grinding	20 - 75
	Other sources	20 - 50

6.2 EMISSION LEVELS FOR DISCHARGES TO WATER

The following table sets out emission levels that are achievable using BAT for wastewater treatment. However establishing emission limit values within a licence for direct discharges to surface water from wastewater treatment plant and stormwater discharges must ensure that the quality of the receiving water is not impaired or that the current Environmental Quality Standards (EQS) are not exceeded.

All discharges to sewer are subject to approval from the Water Services Authority.

Compliance with the Water Framework Directive (2000/60/EC) is required where relevant, in particular Article 16.

Table 6.2: BAT-Associated Emission Levels for Discharges to Water*

Constituent Group or Parameter	Emission Level	Notes
pH	6 - 9	
BOD_5	5 - 25mg/l	
Suspended Solids	35mg/l	
Number of Toxicity Units	1 TU	1
Mineral Oil (Interceptors)	20mg/l	
Metals		2
Priority Substances (as per Water Framework Directive)		2

* All values refer to daily averages based on a 24-hour flow proportional composite sample, except where stated to the contrary and for pH, which refers to continuous values. Levels apply to effluent prior to dilution by uncontaminated streams, e.g. storm water, cooling water, etc.

* Temperature measured downstream of a point of thermal discharge must not exceed the unaffected temperature by more than 1.5°C in salmonid waters and 3°C in cyprinid waters (Freshwater Fish Directive 79/659/EEC).

Note 1: The number of toxic units (TU) = 100/x hour EC/LC50 in percentage vol/vol so that higher TU values reflect greater levels of toxicity. For test regimes where species death is not easily detected, immobilisation is considered equivalent to death. The toxicity of the process effluent to at least two appropriate aquatic species shall be determined.

Note 2: BAT associated emissions levels are highly dependent on production process, wastewater matrix and treatment. These parameters shall be considered on a site-specific basis when setting emission limit values.

7 COMPLIANCE MONITORING

The methods proposed for monitoring the emissions from these sectors are as set out below. Licence requirements may vary from those stated below due to site location considerations, sensitivity of receiving waters, and scale of the operation.

7.1 MONITORING OF EMISSIONS TO AIR

Continuous monitoring of the following from kiln exhausts (with periodic monitoring by specified methods as appropriate): gas volume (or alternative estimation method), temperature, humidity, O_2, CO, NO_X, SO_2 (as appropriate) and particulate matter (opacity may be acceptable as an alternative).

Continuous monitoring of particulate matter in exhaust streams from mills and clinker coolers (opacity may be acceptable as an alternative).

Periodic monitoring of particulates for sources other than kilns, mills, and clinker coolers, typically once per quarter, taking account of the nature, magnitude and variability of the emission and the reliability of the controls.

Periodic monitoring of other parameters specified in BREF Section 1.3.8, as appropriate.

Pressure drop indicators to be fitted to all fabric filters and continuously monitored on major sources.

Where electrostatic precipitators are in use on major sources (e.g. kiln, mills, clinker coolers), corona power should be continuously recorded.

7.2 WASTE WATER DISCHARGES

Establish existing conditions prior to start-up, of key emission constituents, and salient flora and fauna.

Continuous monitoring of flow, volume, temperature (if appropriate), and pH.

Daily monitoring of suspended solids.

Monitoring of other relevant parameters as deemed necessary by the Agency (such as COD, BOD, relevant metals, mineral oil, etc.), taking account of the nature, magnitude and variability of the emission and the reliability of the control techniques.

Toxicity tests, the frequency to be set taking account of the nature, magnitude and variability of the emission and the reliability of the control techniques.

8 PROCESS DESCRIPTION, RISK TO THE ENVIRONMENT AND CONTROL TECHNIQUES – PART B: LIME MANUFACTURE

(Note: any reference to BREF in this document means the reference document on Best Available Techniques in the Cement and Lime Manufacturing Industries, published by the European Commission, December 2001.)

8.1 DESCRIPTION OF PROCESS

The processing steps involved in lime manufacture are as follows:

- Limestone delivery, storage and preparation (see BREF Section 2.2.2)
- Fuel delivery, storage and preparation (see BREF Section 2.2.3)
- Calcination of limestone by burning in a kiln to produce quicklime (see BREF Section 2.2.4). This is a major process step
- Processing of quicklime (see BREF Section 2.2.5)
- Hydrating or slaking quicklime to produce hydrated/slaked lime (where carried out) (see BREF Section 2.2.6)
- Storage, handling and dispatch of products (see BREF Section2.2.7).

There are different types of kilns used to produce lime, including, shaft kilns, rotary kilns, and other kilns, such as fluidised bed kilns (see BREF Section 2.2.4). The main difference between shaft and rotary kilns is in the particle size of the limestone feed, with the former handling a larger size.

8.2 RISK TO THE ENVIRONMENT

The main environmental issues associated with lime manufacture are air pollution and the use of energy. The lime burning process in the kiln is the main source of air emissions and is also the principal user of energy. Emissions to air include nitrogen oxides (NO_x), sulphur dioxide (SO_2), carbon oxides (CO, CO_2), and dust.

In lime manufacture, CO_2 is generated from the combustion of fuel as well as from the liberation of CO_2 during the conversion of $CaCO_3$ to CaO.

8.2.1 Emissions to Air

Nitrogen compounds are emitted from the kiln and are associated with fuel and combustion air (see BREF Section 2.3.3.1).

Sulphur compounds are emitted from the kiln and arise from sulphur in fuel and in limestone (see BREF Section 2.3.3.2).

Dust arises from a number of sources, namely the kiln, lime hydrating, lime grinding, limestone crushing, coal milling, quicklime processing, bulk/bag product filling, and conveying and transport of materials. Fugitive dust emission sources mainly arise from storage and handling of materials (see BREF Section 2.3.3.3).

Other emissions to air from the kiln can include carbon monoxide (CO) (see BREF Section 2.3.3.4), organic compounds (products of incomplete combustion) (see BREF Section 2.3.3.5), dioxins and furans (see BREF Section 2.3.3.5), and metals and their compounds (see BREF Section 2.3.3.5).

8.2.2 Sources of Emissions to Water

There is no process wastewater directly associated with the manufacture of lime (unless wet scrubbers are in use and water is not recycled). Emissions mainly arise from contaminated surface water. The storage and handling of fuel is a potential source of contamination of soil and groundwater.

8.2.3 Sources of Waste

Waste can include dust from abatement systems; out of specification product; and sludges from surface water interceptors and settlement tanks (see BREF Section 2.3.4).

8.2.4 Sources of Noise

The heavy machinery used in lime manufacture can give rise to emissions of noise and/or vibration.

8.3 CONTROL TECHNIQUES

The existing or possible measures for eliminating, reducing and controlling emissions in lime manufacture are described in this section.

8.3.1 General Preventive Techniques

8.3.1.1 Raw Material - Limestone

Use of a kiln that can handle different sizes of limestone, or use of more than one kiln, each of which handles different sizes of limestone (see BREF Section 2.4.1).

Reuse of collected dust back into the process at the point of collection.

8.3.1.2 Use of Energy

In terms of lime manufacturing, the energy efficient techniques outlined in BREF section 2.4.2 and the process control optimisation measures outlined in BREF section 2.4.3 should be noted.

8.3.1.3 Stable Kiln Operation

Maintaining a stable kiln operation will reduce the overall level of emissions due to process upsets, start ups and shutdowns. Process control optimisation measures are outlined in BREF section 2.4.3.

8.3.1.4 Choice of Fuel and Limestone

Careful fuel and limestone selection in conjunction with sufficient control entering the kiln can reduce emissions (see BREF Sections 2.4.4 & 2.4.1).

8.3.1.5 Waste Reduction

In lime hydrating plants, the amount of water needed for addition should be controlled to avoid production of out of specification milk of lime.

8.3.2 Specific Techniques for NOx Emissions

Techniques for controlling NO_x emissions through primary measures include:

Process selection - kiln design (see BREF Section 2.3.3.1)

- Optimisation of kiln operation – maintain stable conditions (see BREF Section 2.4.3).

Low NO_x burners are not applicable to lime manufacture as thermal NO_x is of lesser importance compared to the cement industry.

8.3.3 Specific Techniques for SO_2 Emissions

Techniques for controlling SO_2 emissions during the manufacture of lime through primary measures include (see BREF Section 2.4.6):

- Use of low sulphur fuel
- The sulphur content of the lime produced – producing lime with higher sulphur content will reduce SO_2 emissions
- Choice of process – shaft kilns absorb more SO_2 than rotary kilns (see BREF Section 2.3.3.2)
- Limestone with low sulphur content
- Optimisation of kiln operation – maintain stable conditions (see BREF Section 2.4.3).

Absorbent addition could be used to abate SO_2 emissions. However it is currently not applied in the manufacture of lime.

8.3.4 Specific Techniques for Dust Emissions

8.3.4.1 Minimisation of Dust Emissions

Techniques for minimising dust emissions:

- **Process** dust emissions can be minimised through the use of cyclones prior to dust abatement equipment.
- **Fugitive** dust emissions can be minimised through a simple and linear site layout, paved roads, closed storage with automatic handling, enclosed conveyors for dusty materials/fines, a minimum number of conveyor transfer points, and good housekeeping (see BREF Section 1.4.7.3). Other techniques such as the use of automatic devices and control systems, minimising process upsets, and preventive maintenance will also help prevent fugitive dust emissions.

8.3.4.2 Abatement of Dust Emissions

Techniques for abating dust emissions (summarised in BREF Section 2.4.7) include:

- **Electrostatic precipitators (ESPs)** (see BREF Section 2.4.7.2, 1.4.7.1 & 1.4.4.1).
- **Fabric filters** (see BREF Section 1.4.7.2 for a description of fabric filters, and BREF Section 2.4.7.3 for fabric filter considerations for lime manufacture).
- **Wet scrubbers**. Used on exhaust gases from lime hydrators (see BREF Section 2.4.7.4).
- Techniques for **fugitive dust abatement** include ventilation and collection in fabric filters, mobile and stationary vacuum cleaning, open pile and conveyor wind protection, road wetting, and water spray and chemical dust suppressors (see BREF Section 1.4.7.3).

8.3.5 Techniques for Other Emissions to Air

8.3.5.1 CO_2 and CO

All measures that reduce fuel energy use also reduce associated CO_2 emissions. The selection, where possible, of fuels with a low ratio of carbon content to calorific value reduces CO_2 emissions, and of raw materials with low organic matter content reduces both CO_2 and CO emissions.

8.3.5.2 Metals

The use of materials with a high content of volatile metals should be avoided in the feed to the kiln.

8.3.5.3 Noise

For guidance on measures in relation to noise, have regard to the Guidance Note for Noise in relation to scheduled activities.

8.3.6 Techniques for Recovery and Recycling of Wastes

Particulates collected in dust abatement systems should where practicable be recovered in enclosed systems and incorporated into products. Similarly, it may be possible to incorporate out of specification products into other products. External recycling in other applications may also be possible, for example use in soil stabilisation in civil engineering projects (see BREF Section 2.4.8).

8.3.7 Techniques for Appropriate Disposal of Wastes

After all options for the reduction, recovery, reuse and recycling of wastes have been exhausted, appropriate treatment and disposal of such wastes should be carried out. These include:

- Sludge dewatering
- Landfill of wastes in an appropriately licenses facility.

8.3.8 Techniques for Treating Water Emissions

Contamination of wastewater should be minimised as much as possible through appropriate site layout and design of surface water collection systems, keeping uncontaminated water separate from contaminated water, and good housekeeping measures to minimise the likelihood of contamination by particulates.

Wastewater emissions should be minimised by recycling and re-use wherever practicable. The use of lower quality water may be possible for some parts of the process rather than fresh water.

Treatment of contaminated water may involve:

- pH correction/neutralisation;
- coagulation/flocculation/precipitation;
- sedimentation/filtration/flotation;
- oil/water separator.

9. BEST AVAILABLE TECHNIQUES FOR THE LIME INDUSTRY

9.1 INTRODUCTION

As explained in Section 2, this Guidance Note identifies BAT but obviously does so in the absence of site-specific information. Accordingly, it represents the requirements expected of any new activity covered by the Note, and ultimately the requirement expected of existing facilities, but exclude additional requirements, which may form part of the granting of a licence for a specific site.

The technical feasibility of the measures listed below has been demonstrated by various sources. Used singly, or in combination, the measures represent BAT solutions when implemented in the appropriate circumstances. These circumstances depend on plant scale, process type, etc.

9.2 GENERAL PRIMARY MEASURES

BAT for the manufacture of lime includes the following general primary measures:

A smooth and stable kiln process, operating close to the process parameter set points. This can be obtained by applying:

- Process control optimisation, including computer-based control systems.
- Minimising fuel and energy use by means of:
  - heat recovery from waste gases
  - following the BAT Guidance Note on Energy Use
  - careful selection and control of substances entering the kiln
  - careful selection and control of substances entering the kiln: selection of fuels with low sulphur, nitrogen and chlorine content.

9.3 OXIDES OF NITROGEN

BAT for reducing NO_x emissions are the above-described general primary measures.

9.4 OXIDES OF SULPHUR

BAT for reducing SO_x emissions are the above described general primary measures, and:

- Absorption of SO_2 by particulates trapped in fabric filters.
- Increasing the sulphur content of the lime produced to its maximum allowable level.

9.5 DUST

BAT for reducing dust emissions are the combination of the above described general primary measures and:

- Minimisation and efficient removal of particulate matter from point sources by application of (where applicable):
  - Cyclones

    - Electrostatic precipitators with fast measuring and control equipment to minimise the number of CO trips
    - Fabric filters with multiple compartments and burst bag detectors (for dry waste gases)
    - Wet scrubbers.
- Minimisation/prevention of dust emissions from fugitive sources (see BREF Section 4.3.5.1), and where this is not possible/practicable
- Abatement of dust emissions from fugitive sources (see BREF Section 4.3.5.2).

9.6 WASTE WATER

Effluent should be minimised by recycling and re-use wherever practicable. Storm water, bund water and effluents of different origin should be separated in order to permit appropriate treatment/recycling options. The use of lower quality water may be possible for some parts of the process rather than fresh water.

9.7 WASTE

The recovery and reuse of collected particulate matter and out of specification quicklime and hydrated lime in commercial products, when possible, is considered BAT.

Further information on a number of waste gas wastewater treatment techniques can be found in the BREF document on *Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector*, EIPPCB, February 2003.

10. BAT ASSOCIATED EMISSION LEVELS

10.1 EMISSION LEVELS FOR DISCHARGES TO AIR

The BAT associated emission levels for discharges to air are as set out in the following table:

Table 10.1.1 The BAT associated emission levels for emissions to air

Parameter	Emission Level
Particulates	50 mg/m^3 (on a daily average basis)

10.2 EMISSION LEVELS FOR DISCHARGES TO WATER

The following table sets out emission level values that are achievable using BAT for wastewater treatment. However establishing emission limit values within a licence for direct discharges to surface water from wastewater treatment plant and stormwater discharges must ensure that the quality of the receiving water is not impaired or that the current Environmental Quality Standards (EQS) are not exceeded.

All discharges to sewer are subject to approval from the Water Services Authority.

The BAT associated emission levels for discharges to water are as set out in the following table:

Table 10.2.1 The BAT associated emission levels for emissions to water *

Parameter	Emission Levels	Notes
pH	6 - 9	
Temperature	25°C (Max.)	
Suspended Solids	35 mg/l	
BOD	25mg/l	
Priority Substances (as per Water Framework Directive)		1
Other		1

* All values refer to daily averages based on a 24-hour flow proportional composite sample, except where stated to the contrary and for pH, which refers to continuous values. Levels apply to effluent prior to dilution by uncontaminated streams, e.g. storm water, cooling water, etc.

* Any relevant polluting substances as specified in Schedule to S.I. No. 394 of 2004: EPA (Licensing)(Amendment) Regulations, 2004.

Note 1: BAT associated emissions levels are highly dependent on production process, wastewater matrix and treatment. These parameters shall be considered on a site-specific basis when setting emission limit values.

11. COMPLIANCE MONITORING

The methods proposed for monitoring the emissions from these sectors are set out below. Licence requirements may vary from those stated below due to site location considerations, sensitivity of receiving waters, and scale of the operation.

11.1 MONITORING OF EMISSIONS TO AIR

Periodic monitoring of particulates, NO_X, SO_2, CO, and CO_2, the frequency to be set taking account of the nature, magnitude and variability of the emission and the reliability of the controls.

Where electrostatic precipitators are in use on major sources, corona power should be continuously recorded and continuous monitoring of CO should be carried out.

Where considered necessary due to the nature, magnitude and variability of the emission and the reliability of the controls continuous monitoring of particulate matter, NO_X, and SO_2 (depending on fuel used), in exhaust streams from kilns may be required. For particulates, opacity may be acceptable as an alternative.

11.2 MONITORING OF AQUEOUS EMISSIONS

Establish existing conditions prior to start-up, of key emission constituents, and salient flora and fauna.

For effluent - Daily, or where necessary, continuous monitoring of flow, volume, and pH and daily monitoring of suspended solids. Monitoring of other relevant parameters as deemed necessary by the Agency (such as COD, relevant metals, etc.), taking account of the nature, magnitude and variability of the emission and the reliability of the control techniques.

Appendix 1

PRINCIPAL REFERENCES

1. E.C.

1.1 Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries (December 2001).

1.2 Council Directive 96/61/EC of 24 September 1996 concerning Integrated Pollution Prevention and Control.

2. IRELAND

2.1 Integrated Pollution Control Licensing BATNEEC Guidance Note For The Production of Cement (EPA No. LC 12 (2/96)).

2.2 Integrated Pollution Control Licensing BATNEEC Guidance Note For Noise in Relation to Scheduled Activities (EPA No. LC 8 (1995)).

2.3 Guidance Note For Noise in Relation to Scheduled Activities 2ND Edition (EPA (2006))

Appendix 2

GLOSSARY OF TERMS AND ABBREVIATIONS

BAT	Best Available Technique
BOD	Biochemical Oxygen Demand
BREF	Reference document on Best Available Techniques in the Cement and Lime Manufacturing Industries, published by the European Commission, December 2001
°C	Degree Celsius
CO	Carbon monoxide
COD	Chemical Oxygen Demand
CO_2	Carbon dioxide
ESP	Electrostatic Precipitator
F	Fluorine
HCl	Hydrochloric acid
HF	Hydrofluoric acid
kg	Kilogramme
K	Degree Kelvin (0 °C = 273.15 K)
m^3	Cubic metre
mg	Milligramme
MJ	Megajoule (1 MJ = 1000 kJ = 10^6 joule)
N_2	Nitrogen
Nm^3	Normal cubic metre (101.3 kPa, 273 K)
NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
O_2	Oxygen
SCR	Selective Catalytic Reduction
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulphur dioxide
SO_x	Sulphur oxides
t	Tonne (metric)
VOC	Volatile Organic Compounds