BAT Guidance Note on Best Available Techniques for the Manufacture of Ceramic Products and Industrial Diamonds

(1st Edition)

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Contents

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) licences 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
3	Sector Covered by this Guidance Note
4	Process Description, Risk to the Environment and Control Techniques
5	Best Available Techniques
6	BAT Associated Emission Levels
7	Compliance Monitoring

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. Operators should therefore continue to keep up to date with the best available techniques relevant to the activity and discuss appropriate innovations with the EPA.

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 BATNECC (Best Available Technology not Entailing Excessive Costs) with BAT.

Best available techniques (BAT) is defined in Section 5 of the Protection of the Environment Acts 2003 and 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 and 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 on the activity.

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

The range of emission limit 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 available options may be needed to establish the best option. The choice may be justified on:

- technical characteristics of the installation/facility;
- its geographical location;
- local environmental considerations;
- the economic and technical viability of upgrading existing installation/ facility;

The overall objective of ensuring a high level of protection for the environment as a whole will often involve making a judgment between different types of environmental impact, 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 and is demonstrated to the Agency to satisfy the requirement of BAT.

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. SECTOR COVERED BY THIS GUIDANCE NOTE

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

4.4 The production of industrial diamonds.

13.4.1 The manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tonnes per day, or with a kiln capacity exceeding 4 m^3 and a setting density per kiln exceeding 300 kg/m^3.

13.4.2 The manufacture of coarse ceramics including refractory bricks, stoneware pipes, facing and floor bricks and roof tiles, not included in paragraph 13.4.1.

4. PROCESS DESCRIPTION, RISK TO THE ENVIRONMENT AND CONTROL TECHNIQUES

Note: any reference to CMI-BREF in this document means the *Draft Reference Document on Best Available Techniques in the Ceramic Manufacturing Industry*, December 2006.

4.1 DESCRIPTION OF PROCESS

The Ceramic Manufacturing Industry is considered to be comprised of nine sectors. Due to the wide variety of ceramic products possible, the various sectors are summarised into two groups (coarse ceramics and fine ceramics) with references to the application of different types of products covering the key environmental aspects and addressing common issues for all ceramics. Common BAT related themes for all ceramic sectors include raw materials usage, additives usage, manufacturing techniques and product properties.

These nine sectors are based on the products manufactured, but inevitably there is some overlap between them in terms of operations carried out during the manufacturing process. The nine sectors are:

Coarse Ceramics

1. Bricks and Roof Tiles (including chimney flues)
2. Refractory Products
3. Vitrified Clay Pipes
4. Expanded Clay Aggregates

Fine Ceramics

5. Wall and Floor Tiles
6. Table and Ornamentalware (Household Ceramics)
7. Sanitaryware
8. Technical Ceramics
9. Inorganic Bonded Abrasives (including Industrial Diamonds)

The manufacture of coarse and fine ceramic products may take place in different types of kilns, with a wide variety of raw materials and in numerous shapes, phases, sizes and colours. The general process of manufacturing ceramic products is rather uniform, besides for the manufacture of fine ceramics a multiple stage firing process is often used (with the exception of inorganic bonded abrasives).

Some process steps apply to all of the manufacturing sectors such while other are more sectoral specific. The principal steps involved in the Ceramics manufacturing process are:

1. Storage and Transport of Raw Materials (See CMI-BREF Section 2.2.1)
2. Preparation of Raw Materials (See CMI-BREF Section 2.2.2)

- Pre-drying and Pre-blending,
- Weathering/Souring,
- Primary and secondary crushing, grinding and screening,
- Dry or wet milling,
- Dry screening/Air Classification,
- Spray Drying,
- Calcining, and
- Frits and Glazes/Glaze Preparation.

3. Component Mixing – Continuous Mixers and Batch Mixers (See CMI-BREF Section 2.2.3)
4. Shaping/forming of Ware (See CMI-BREF Section 2.2.4)
    - Pressing (mechanical, hydraulic, impact, friction, isostatic),
    - Extrusion,
    - Moulding,
    - Slip casting, and
    - Fusion casting.
5. Drying of Ceramic Products (See CMI-BREF Section 2.2.5)
    - Hot Floor Dryers,
    - Chamber Dryers,
    - Tunnel Dryers,
    - Vertical Basket Dryers,
    - Horizontal Multi Deck roller dryers,
    - Dehumidifying Dryers, and
    - Infrared and Microwave dryers.
6. Surface Treatment and Decoration of Ceramic Product (See CMI-BREF Section 2.2.6)
    - Texturing,
    - Applied Facings, and
    - Engobing, Glazing and other decorative techniques.
7. Firing (See CMI-BREF Section 2.2.7)
    - Intermittent Kilns,
    - Continuous Kilns (Chamber, Tunnel, Roller Hearth and Sliding Bat Kilns),
    - Clamp Firing,
    - Rotary Kilns,
    - Fluidised Beds, and
    - Cooling stage heat recovery.
8. Subsequent Treatment (Product Finishing) (See CMI-BREF Section 2.2.8)
    - Machining (wet grinding, dry grinding, drilling, sawing),
    - Polishing,
    - Carbon Enrichment (Refractory Products),
    - Tumbling of Facing Bricks.
9. Addition of Ancillary Materials

For sectoral specific process descriptions, see CMI-BREF Section 2.3.

4.2 RISK TO THE ENVIRONMENT

Depending on the specific production processes, plants making ceramic products cause emissions to be released into air, water and land (waste). Additionally, the environment can be affected by noise and unpleasant odours. The type and quantity of air pollution, wastes and waste water depend on different variables. These variables are, e.g. the raw materials used, the auxiliary agents employed, the fuels used and the production methods.

4.2.1 Energy Consumption

All sectors of the ceramic industry are energy intensive, as a key part of the process involves drying followed by firing to temperatures of between 800 and 2,000ºC. For the manufacture of porcelain, energy accounts for between less than 10 to 18% of the total costs. For the manufacture of bricks, the share of the energy costs vary between 17% and 25% with maximum levels of up to 30%.

Throughout Europe natural gas, liquefied petroleum gas (propane and butane) and fuel oil are mainly used for firing, while heavy fuel oil, coal, liquefied natural gas (LNG) and electricity only play a minor role as energy sources for burners. For the manufacture of fine ceramics, natural gas is the most commonly used fuel and also electricity is applied to a certain extent (for instance technical ceramics in 2003: approx. 2/3 gas and 1/3 electricity). The use of heavy fuel oil and coal is limited mainly to a few coarse ceramics plants, most of them being brickworks (See CMI-BREF Section 3.2.1).

4.2.2 Water Consumption

Water is used in virtually all ceramic processes, and good quality water is essential for:

- the preparation of clays and glaze slips (See CMI-BREF Section 2.2.3, 2.2.2.10 & 2.3);
- clay bodies for extrusion and ‘muds’ for moulding (See CMI-BREF Section 2.2.3 & 2.3);
- the preparation of spray dried powders (See CMI-BREF Section 2.2.2.7 & 2.3);
- wet grinding/milling (See CMI-BREF Section2.2.2.5 & 2.2.8 & 2.3); and,
- washing operations (See CMI-BREF Section 2.2 & 2.3).

4.2.3 Emissions to Air

Particulate matter/dust can arise from the handling or processing of raw materials or product and also soot can arise from firing fuel oil. Vapour or Gaseous emissions can arise during or spray-drying of ceramics and may be derived from the raw materials and/or from the fuels employed. Carbon oxides, nitrogen oxides, sulphur oxides, inorganic fluorine and chlorine compounds, as well as organic compounds are of particular relevance among the gaseous and vapour emissions. Due to the use of substances for decorative purposes, which may contain heavy metals, or due to the usage of heavy oil as fuel, heavy metals can also be emitted (See CMI-BREF Section 3.1.1).

4.2.4 Emissions to Water

Water is a very important raw material in the ceramic manufacturing industries, but the amount used varies greatly between sectors and processes. The water added directly to ceramic body mixes does not lead to a wastewater problem, as it is subsequently evaporated into the air during the drying and firing stages. Process waste water is generated mainly, when clay materials are flushed out and suspended in flowing water during the manufacturing process and equipment cleaning, but emissions to water also occur during the operation of wet-off gas scrubbers.

Process waste water occurs in small quantities in the manufacture of coarse ceramics, if surface treatment such as glazing and engobing, or wet grinding is carried out. Additional amounts of water arise in the cleaning process of the mixing, engobing and glazing units, and cleaning of moulds. In the fine ceramics industry, process waste water occurs mainly as cleaning water in preparation units, in casting units, in the glazing and decorations process or as grinding water in subsequent treatment.

The waste water in the process mostly shows turbidity and colouring owing to the very fine suspended particles of glaze and clay materials. From a chemical point of view, these are characterised by the presence of:

- Suspended Solids: clays, frits and insoluble silicates in general;
- Dissolved anions: sulphates;
- Suspended and dissolved heavy metals: e.g. lead and zinc;
- Boron in small quantities; and,
- Traces of organic matter (screen printing vehicles and glues used in glazing operations).

Apart from process waste water, which often is cleaned and re-used in closed circuits, also cooling water, rainwater and sanitary waste water occur in the plant (See CMI-BREF Section 3.1.2 and 3.2.2).

4.2.5 Emissions of Other Waste

Waste originating from manufacture of ceramic products, mainly consist of the following materials:

- Different kinds of sludge (sludge from process waste water treatment, glazing sludge, plaster sludge, grinding sludge);
- Broken ware from shaping, drying, firing and refractory material;
- Dust from flue-gas cleaning and dedusting units;
- Used plaster moulds;
- Used sorption agents (granular limestone, limestone dust); and,
- Packaging waste (plastic, wood, metal, paper, etc.).

Some of the above mentioned waste products can be recycled and re-used within the plant if certain product specifications or process requirements allow. Materials, which cannot be recycled internally, leave the plant as waste and are generally supplied to external recycling or disposal facilities (See CMI-BREF Section 3.1.3).

4.2.6 Emissions of Noise

Noise occurs in the several steps during the manufacturing processes of ceramic products, mainly by operating noise generating machinery and by carrying out noisy working procedures. Some examples include:

- Primary/Secondary crushing and grinding;
- Screening/classification;
- Granulation;
- Shaping of ceramics by cutting; and,
- Drying process.

4.3 CONTROL TECHNIQUES

The existing or possible measures for eliminating, reducing and controlling emissions in the Ceramic Manufacturing Industry are described in this Section. References to more details and descriptions in the BREF document are provided.

4.3.1 Reduction of energy consumption (energy efficiency)

Several different measures can be applied to reduce energy consumption individually or in combination:

- Improved design of kilns and dryers (See CMI BREF Section 4.1.1)
- Recovery of excess heat from kilns (See CMI BREF Section 4.1.2)
- Cogeneration/combined heat and power plants (See CMI BREF Section 4.1.3)
- Substitution of heavy fuel oil and solid fuels by clean fuels (See CMI BREF Section 4.1.4)
- Modification of ceramic bodies - sophisticated design of ceramic body composition can reduce necessary drying and firing times which can result in reduced energy consumption in these areas (See CMI BREF Section 4.1.5).

4.3.2 Emissions of dust (particulate matter)

In this section, techniques and measures to prevent diffuse and channelled emissions are described. Useful information can also be found in the BREF on emission from Storage and in the BREF on *Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector* [Note 1].

4.3.2.1 Preventative Techniques

Here several different measures are presented, which can be applied individually or in combination (See CMI BREF Section 4.2.1):

- Enclosure of dusty operations, such as grinding, screening and mixing;

Note 1 Reference Document on the Best Available Techniques on Emission from Storage, January 2005 & Reference Document on the Best Available Techniques in Common Waste Water and Waste Gas Treatment/Management in the Chemical Sector, adopted February 2003

- The use of covered and vented trough or pan mixers;
- Filtration of air displaced whilst charging mixers or dosing equipment;
- Storage silos with adequate capacity, level indicators with cut out switches and with filters to deal with dust-bearing air displaced during filling operations;
- Covered conveyor belts for potentially dusty raw materials;
- A circulation process is favoured for pneumatic conveying systems;
- Material handling in closed systems maintained under negative pressure and de-dusting of the suction air; and,
- Reduction of air leakage and spillage points, completion of maintenance of installation.

4.3.2.2 Use of Separation/Filter systems (See CMI BREF Section 4.2.3)

- Centrifugal separators;
- Bag Filters;
- Sintered lamellar filters;
- Wet dust separators; and,
- Electrostatic precipitators (ESP).

4.3.3 Vapour and Gaseous Emissions

The following measures can be applied individually or in combination to reduce the emission of vapour and gaseous compounds (See CMI BREF Section 4.3):

- Reduction of input of pollutant precursors (See CMI BREF Section 4.3.1);
- Addition of calcium rich additives (See CMI BREF Section 4.3.2);
- Process optimisation (See CMI BREF Section 4.3.3):
  - Optimising the heating curve;
  - Reduction of water vapour levels in the kiln gases;
  - Internal carbonisation gas combustion;
  - Low NOx burners;
- Sorption Plants (adsorbers, absorbers) (See CMI BREF Section 4.3.4):
  - Cascade-type packed bed adsorbers;
  - Module adsorber systems;
  - Dry flue-gas cleaning with a filter (bag filter or electrostatic precipitator);
  - Wet flue-gas cleaning;
  - Activated carbon filters;
  - Biological scrubbers;
- After burning (See CMI BREF Section 4.3.5):
  - Thermal afterburning in a thermoreactor; and,
  - Catalytic afterburning.

4.3.4 Water/ Waste Water Management

(See CMI BREF Section 4.4)

Water management includes the efficient use of this natural resource and preventing or reducing the production of water pollution. Water pollution control can be achieved by:

- Reducing the volume of wastewater generated;
- Reducing the strength of the wastewater generated;
- Eliminating or decreasing the concentration of certain pollutants;
- Recycling or re-use water; or
- A combination of these measures.

Further water management techniques such as the following may be implemented:

- Provide water in sufficient amounts and suitable quality;
- Implement a water management system;
- Apply a methodology for reducing water consumption;
- Eliminate the use of water wherever possible:
  - Utilise closed circuit cooling systems instead of once-through cooling, this eliminates most of the water waste in cooling;
- Optimise existing processes to reduce water usage;
- Implement good housekeeping by monitoring for water leaks and faults and repairing them promptly. Also monitor water consumption on high-use equipment;
- Implement an efficient program of maintenance of utility systems; and,
- Wastewater treatment.

The main process waste water treatment techniques are as follows (see CMI BREF Section 4.4.5.2): [Note 2]

1. **Homogenisation:** homogenisation tanks are used to obtain a consistent composition in the water to be treated, and suppress, as far as possible, problems relating to variations in the constituents. Using such tanks yield improvement in all subsequent treatments, as the resulting homogeneity facilitates control of product additions and consistency in the operating facilities.
2. **Aeration:** this is a physical process that is frequently used in water treatment for different purposes, such as oxidation of the materials to facilitate subsequent flocculation, oxygenation of the organic compounds present in the process waste water, eliminating odours, etc. Aerating equipment may involve surface stirrers or turbines.
3. **Sedimentation (settling):** this is the partial separation of solid particles from a liquid by gravity. There are various types of settling tanks; these may be rectangular, round or lamellar.

[Note 2] Also see Reference Document on the Best Available Techniques in Common Waste Water and Waste Gas Treatment/Management in the Chemical Sector, adopted February 2003.

4. **Filtration:** filtration involves the separation of suspended solids from a liquid, by putting the suspension through a porous medium that retains the solids and allows the liquid to flow through. The types used in the ceramic industry are in-depth filters, filter presses, and rotating vacuum filters.
5. **Activated carbon absorption:** this treatment is based on carbons ability to strongly absorb organic molecules present in water. This is a very suitable system for removing non-biodegradable organic substances.
6. **Chemical precipitation:** this is a process for eliminating different dissolved elements by precipitation as insoluble compounds, using reagents such as lime.
7. **Coagulation and flocculation:** the purpose of this treatment is to break up colloidal suspensions and produce particle agglomeration, e.g. by use of alums or polyelectrolyte.
8. **Ion exchange and reverse osmosis:** these processes serve to remove boron from the cleaning water coming from the glaze and application sections. Reverse osmosis is also applied for reducing the amount of process waste water for discharge.

By applying these measures or a combination of them, significant reductions of process waste water emissions and lower water consumption (see also table 4.8 in CMI BREF) can be achieved.

5. BEST AVAILABLE TECHNIQUES FOR THE CERAMICS AND INDUSTRIAL DIAMOND SECTOR

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 requirements expected of existing facilities, but exclude additional requirements, which may form part of the granting of a licence for a specific site.

The approach to be used in selecting BAT is based on the following hierarchy:

- Process design/redesign changes to eliminate emissions and wastes;
- Waste reduction by means of process control, inventory control, etc.;
- Substitution of fuels, etc., with environmentally less harmful materials;
- Reuse of materials within the process and in products;
- Recycling of wastes in other applications;
- End-of-pipe techniques to control, abate or treat emissions; and,
- Safe Disposal.

The technical feasibility of the measures listed below have 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 nature of process, plant scale, fuels used, etc.

5.2 BAT - GENERIC PREVENTATIVE MEASURES

For the ceramic manufacturing industry, BAT is to do the following:

- Operate an environmental management system (See CMI BREF Section 4.7 and 5.1.1)
- Substitution or reduction of the use of some auxiliary materials, e.g. fuels, chemicals to minimise environmental impacts (See CMI BREF Sections 4.1.4)
- Employ good housekeeping practices.

5.2.1 Environmental Management Systems

A number of environmental management techniques are determined as BAT. The scope (level of detail) and nature of the EMS (standardised or non-standardised) will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have (See CMI BREF Section 5.1.1).

An Environmental Management System (EMS) is a tool that operators can use to address design, construction, maintenance, operation and decommissioning issues in a systematic, demonstrable way. An EMS includes the organisational structure, responsibilities, practices, procedures, processes and resources for developing,

implementing, maintaining, reviewing and monitoring the environmental policy. Environmental Management Systems are most effective and efficient where they form an inherent part of the overall management and operation of an installation.

An environmental management system (EMS) for an IPPC installation contains the following components:

a. Defining of an environmental policy
b. Planning and establishing objectives and targets
c. Implementing and operating procedures
d. Checking and corrective action
e. Management review
f. Preparing a regular environmental statement
g. Validating by certification body or external EMS verifier
h. Considering design for end-of-life plant decommissioning
i. Development of cleaner technologies
j. Benchmarking.

5.2.2 Minimisation of Energy Consumption

For the minimisation of energy consumption BAT is to do the following:

- Improved design of kilns and dryers (see CMI BREF Section 4.1.1). Several different measures can be applied to kiln/dryer systems individually or in combination
- Recovery of excess heat from kilns, especially from the cooling zones (see CMI BREF Section 4.1.2)
- Kiln firing process - Substitution of heavy fuel oils and solid fuels by clean fuels (See CMI BREF Section 4.1.4)
- Modification of ceramic bodies (See CMI BREF Section 4.1.5)
- Cogeneration/combined heat and power plants (see CMI BREF Section 4.1.3).

5.2.3 Minimisation of Dust Emissions

For the minimisation of dust emissions BAT is to do the following:

- Implement measures to reduce the emissions of dust from diffuse dusty operations (See CMI BREF Section 4.2.1 and 4.2.2)
- Implement measures to reduce dust emission from channelled dust emission points from dusty operations (See CMI BREF Section 4.2.3).

5.2.4 Minimisation of Emissions to Air

For the minimisation of emissions to air, BAT is to do the following:

- Implementation of Primary reduction measures/techniques:
  - Reduction of input of pollutant precursors (See CMI BREF Section 4.3.1)
  - Addition of calcium rich additives (See CMI BREF Section 4.3.2)

- Optimising the heating curve of the firing process (See CMI BREF Section 4.3.3.1)
- Reduction of water vapour levels in the kiln gases (See CMI BREF Section 4.3.3.2)
- Internal carbonisation gas combustion (See CMI BREF Section 4.3.3.3)
- Low-NO_X burners (See CMI BREF Section 4.3.3.4).

- Implementation of Secondary Reduction Measures/Techniques and combination with Primary Reduction Measures/Techniques:
  - Cascade type packed bed adsorbers (See CMI BREF Section 4.3.4.1)
  - Module Adsorbers (See CMI BREF Section 4.3.4.2)
  - Dry flue-gas cleaning with a filter (bag filter or electrostatic precipitation (See CMI BREF Section 4.3.4.3)
  - Wet flue-gas cleaning (See CMI BREF Section 4.3.4.4)
  - Activated carbon filters (See CMI BREF Section 4.3.4.5)
  - Biological scrubbers (See CMI BREF Section 4.3.4.6).

5.2.5 Minimisation of Water Emissions/Consumption

For the minimisation of water consumption and emissions, BAT is to do the following:

- Eliminate the use of water where possible or where not feasible to apply a methodology for reducing water consumption (See CMI BREF Section 4.4.5.1).
  - Installing automatic valves in the water circuit that prevent leaks of water when it is not needed
  - Installation of high pressure system in the plant for cleaning purposes
  - Switching from wet off-gas cleaning systems to alternative, non-water consuming systems (See CMI-BREF Section 4.2.3 and 4.3.4)
  - Installation of ‘in-situ’ waste glaze collection systems
  - Separate collection of process waste water streams from different process steps
  - Reuse of process waste water in the same process steps, in particular repeated reuse of the cleaning water after suitable treatment
- Clean process wastewater by applying relevant treatment systems (See CMI BREF Section 4.4.5.2)
- Reduce the emission load of pollutants to the levels specified in Table 5.2.5. These levels are process related and should be read in conjunction with Section 6 of this Note.

Table 5.2.5 BAT wastewater pollutant levels

Parameter	Wastewater Pollutant Level [Note 1] mg/l
Suspended solid	50
AOX	0.1
Lead (Pb)	0.3
Zinc (Zn)	2.0
Cadmium (Cd)	0.07

Note 1: If more than 50% of the process water is re-used in the manufacturing processes, higher concentrations of these pollutants may be allowed where the specific pollutant load per production unit (kg of processed raw material) is not higher than the pollutant load resulting from a water recycling rate of less than 50%.

5.2.6 Waste Management

For waste management, BAT is to do the following:

- Implement a waste minimisation programme
- Improve operating practices to reduce solid waste losses by the implementation of one or a combination of the following:
  - Reuse of unmixed raw materials (See CMI BREF Section 4.5.2.1)
  - Reuse of broken ware into the manufacturing process (See CMI BREF Section 4.5.2.1)
  - Reuse of broken ware in other industries (See CMI BREF Section 4.5.2.1)
  - Electronic controlling of firing (See CMI BREF Section 4.5.2.2)
  - Applying optimised settings (See CMI BREF Section 4.5.2.2)
- Apply appropriate storage and handling techniques to control emissions such as dust during loading/unloading, conveying and storage (See CMI BREF Sections 4.2.2).

5.2.7 Prevention of Noise Emissions

For general preventative measures for abatement of noise (see CMI BREF Section 5.1.8), BAT is to:

- Enclose Units
- Vibration insulate Units
- Use silencers and slow rotating fans
- Situate windows, gates and noisy units away from neighbours
- Sound insulate windows and walls
- Carry out noisy (outdoor) activities only during the day
- Carry out good maintenance of the plant.

5.2.8 Other Waste Emissions

Wherever practicable, the prevention or where that is not practicable, the minimisation of waste by primary means is considered to constitute BAT. Wherever practicable, the feedback of unmixed raw materials, feedback of broken ware into the manufacturing process, etc. is considered BAT (See CMI-BREF Section 4.5.2).

BAT is to reduce solid process losses (waste) by applying a combination of the following:

- Reduced waste (on site only)
- Generally improved energy efficiency
- Contribution to minimising certain other emissions
- Reduced consumption of natural resources.

5.3 BAT - Measures for Treatment, Abatement and Disposal

5.3.1 Energy Consumption

BAT is to reduce energy consumption for the manufacture of wall and floor tiles and household ceramics by applying cogeneration (i.e. production of heat and electricity simultaneously - see CMI BREF Section 4.1.3), especially if spray drying processes are carried out in new plants.

5.3.2 Channelled Dust Emissions

BAT is to reduce channelled dust emissions from spray drying processes in the manufacture of wall and floor tiles, household ceramics and technical ceramics to 20-50 mg/m^3, as half an hour average value, by applying wet dust separators, if the rinsing water can be re-used (see CMI BREF Section 4.2.3.4).

BAT is to reduce channelled dust emissions from spray glazing processes in the manufacture of wall and floor tiles, household ceramics, sanitaryware and technical ceramics to 20-50 mg/m^3, as half an hour average value, by applying wet dust separators, if the rinsing water can be re-used (see CMI BREF Section 4.2.3.4).

BAT is to reduce channelled dust emissions from hot off-gases in the manufacture of expanded clay aggregates to 5-50 mg/m^{3,} as a daily average value, by applying electrostatic precipitators (see CMI BREF Section 4.2.3.5).

5.3.3 Volatile organic compounds

BAT is to reduce the emissions of volatile organic compounds in low off-gas volumes from the heat treatment of organic binders in the manufacture of refractory products by applying activated carbon filters (see CMI BREF Section 4.3.4.5).

BAT is to reduce the emissions of volatile compounds from the flue-gases of firing processes of bricks (in particular clay blocks), refractory products, technical ceramics and inorganic bonded abrasives to 5-20 mg/m^{3,} as a daily average value stated as total C, by applying thermal afterburning in a thermoreactor (see CMI BREF Section 4.3.5.1).

5.3.4 Re-use of Process Waste Water

BAT is to re-use process waste water in the manufacturing process with process waste water recycling ratios of 50-100% for the manufacture of wall and floor tiles (depending on the type of tile to be manufactured, see Section CMI BREF 4.4.5.1) and 50% for the manufacture of household ceramics and sanitaryware by applying a combination of process optimisation measures and process waste water treatment systems as stated in CMI BREF Section 4.4.5.

5.3.5 Re-use of Sludge

BAT is to re-use the sludge arising from process waste water treatment in the ceramic body preparation process of the manufacture of wall and floor tiles in a ratio of 0.4-1.0% of added kg dry sludge per kg ceramic body, by applying a sludge recycling system (see CMI BREF Section 4.5.1.1).

5.3.6 Solid Process Losses (Waste)

BAT is to reduce the amount of solid process losses (waste) in the form of used plaster moulds from the shaping of roof tiles, refractory products, household ceramics sanitaryware and technical ceramics by applying one or a combination of the following measures (see CMI BREF Section 4.5.2.2):

- Replacing plaster moulds by polymer moulds;
- Replacing plaster moulds by metal moulds;
- Use of vacuum plaster mixers;
- Re-use of used plaster moulds in other industries.

6. BAT ASSOCIATED EMISSION LEVELS

6.1 EMISSION LEVELS FOR DISCHARGES TO AIR

The BAT associated emission levels for emission to air is as shown in Table 6.1 below.

Table 6.1 – BAT associated Emission Level Values for the Ceramic Manufacturing Industry (See CMI BREF Section 5.1 and 5.2)

Process/Parameter	**mg/Nm^3 daily average value** note 4
Kiln Firing	
Particulates	1 - 50
Fluoride as HF	5 - 10
Chloride as HCl	1 - 30
NOx	250 - 500
SOx	500 Note 5
VOC Note 1	5 - 20
Spray Drying Processes	
Particulates Note 2	1 - 50
Spray Glazing	
Particulates Note 2	1 - 10
Hot Off Gases	
Particulates Note 3	5 - 50
Channelled dust emissions from dusty operations	
Particulates	1 - 10

Note 1 Refers to Brick and Roof Tiles, Refractory Products, Technical Ceramics and Inorganic Bonded Abrasives (industrial diamond) Sectors.

Note 2 Refers to Household Ceramics, Wall and Floor Tiles and Technical Ceramics Sector.

Note 3 Relates to hot off gases in the manufacture of expanded clay aggregates when using electrostatic precipitation.

Note 4 The ranges depend on the content of the pollutant (precursor) in the raw material, i.e. for firing processes of ceramic products with a low content of the pollutant (precursor) in the raw materials, lower levels in the ranges are associated with BAT and for firing processes of ceramic product with a high content of pollutant (precursor) in the raw materials, higher levels within the ranges are associated with BAT.

Note 5: Where the sulphur content in the raw material is greater than 0.25% this value may be increased to a maximum of 2,000mg/m^3.

6.2 EMISSION LEVELS FOR DISCHARGES TO WATER

Effluent 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.

All releases to controlled waters are subject to a licence from the Agency. However, any discharge to a sewer, will require the consent of the Water Services Authority. BAT to minimise the release of substances will generally include minimisation at source (see CMI-BREF Section 4.4.5.1) and either specific treatment of individual waste water streams to remove particular substances or co-treatment of combined effluent streams or both (see CMI-BREF Section 4.4.5.2).

The following table sets out emission levels that are achievable using BAT for wastewater treatment and should be read in conjunction with Table 5.2.5. 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^{o}C in salmonid waters and 3^{o}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 the sector 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.

7.1 MONITORING OF EMISSIONS TO AIR

- Quarterly monitoring of Kiln Stack Emissions for SOx, NOx, Fluorides, Chlorides, particulates and any other parameter deemed necessary by the Agency, as required by the license, taking account of the nature, magnitude and variability of the emission and the reliability of the controls.
- Quarterly monitoring for particulates and any other parameter deemed necessary by the Agency from Spray Drying, Spray glazing processes, as required by the license, taking account of the nature, magnitude and variability of the emission and the reliability of the controls.
- Biannual Monitoring of Boiler combustion efficiency in accordance with the manufacturer's instruction at a frequency determined by the agency.
- Odour Monitoring should be conducted, if requested by the Agency, at the nearest odour sensitive receptor location(s) at a frequency determined by the Agency.

7.2 MONITORING OF AQUEOUS EMISSIONS

The following monitoring requirement should be considered:

- Continuous monitoring of flow discharge from wastewater treatment plant and any other parameter deemed necessary by the Agency.
- Daily monitoring of pH, temperature and any other relevant parameter deemed necessary by the Agency, taking account of the nature, magnitude and variability of the emission and the reliability of the control technique.
- For uncontaminated surface waters, continuous monitoring pH and COD.
- Periodic non-continuous monitoring of discharges for pollution parameters as requested by the Agency.
- Establish existing conditions prior to start-up, of key emission constituents, and salient flora and fauna.

7.3 MONITORING OF EMISSIONS TO GROUNDWATER

There should be no direct process emissions to groundwater, including during the extraction and treatment of groundwater.

Appendix 1

PRINCIPAL REFERENCES

1. E.C.

1. Council Directive 96/61/EC of 24 September 1996 concerning Integrated Pollution Prevention and Control.
2. Reference Document on Best Available Techniques in the Ceramic Manufacturing Industry published by the European Commission, December 2006.
3. Reference Document on Best Available Techniques on Emissions from Storage (January 2005).
4. Reference Document on Best Available Techniques in common wastewater and waste gas treatment/management systems in the chemical sector (February 2003).

2. IRELAND

1. BATNECC Guidance Note for Coarse Ceramics.
2. Integrated Pollution Control Licensing BATNEEC Guidance Note For Noise in Relation to Scheduled Activities (EPA No. LC 8 (1995)).
3. Guidance Note For Noise in Relation to Scheduled Activities 2ND Edition (EPA (2006))

Appendix 2

Glossary of Terms and Abbreviations

BAT	Best Available Techniques
BATNEEC	Best Available Techniques Not Entailing Excessive Cost
BOD	Biochemical Oxygen Demand
BREF	Reference Document on Best Available Techniques in the Ceramic Manufacturing Industry published by the European Commission, December 2006
°C	Degree Celsius
CO	Carbon monoxide
COD	Chemical Oxygen Demand
CO_2	Carbon dioxide
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
ELV	Emission Limit Value
EMP	Environmental Management Programme
EMS	Environmental Management System
EPA	Environmental Protection Agency
EQO	Environmental Quality Objective
EQS	Environmental Quality Standard
IPC	Integrated Pollution Control; as established by the EPA Act of 1992
IPPC	Integrated Pollution Prevention and Control
mg	Milligram
Nm^3	Normal cubic metre (101.3 kPa, 273 K)
NO_x	Nitrogen oxides
POE	Protection of the Environment Act 2003
US EPA	United States Environmental Protection Agency
WMA	Waste Management Act
VOC	Volatile Organic Compounds