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Sector Guidance Note IPPC SG7

Integrated Pollution Prevention and Control (IPPC)

Secretary of State's Guidance for the A2 Ceramics Sector Including Heavy Clay, Refractories, Calcining Clay and Whiteware

September 2007

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

defra
Department for Environment Food and Rural Affairs

Department for Environment, Food and Rural Affairs
Nobel House
17 Smith Square
London SW1P 3JR

Tel: 020 7238 6000
Website: www.defra.gov.uk

Information about this publication and copies are available from:

Defra
Area 3C, Ergon House
17 Smith Square
London SW1P 3JR

Tel: 020 7238 1689

Email: pgnotes@defra.gsi.gov.uk

This document is available on the Defra website.

Published by the Department for Environment, Food and Rural Affairs

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1 Introduction

Background

1.1 This sector guidance note is issued by the Secretary of State and the Welsh Assembly Government (WAG), following consultation with relevant trade bodies, representatives of regulators including members of the Industrial Pollution Liaison Committee, and other interested organisations.

1.2 The note constitutes statutory guidance under regulation 37 of the Pollution Prevention and Control (England and Wales) Regulations 2000, SI 1973 (**Ref 1**) on the integrated pollution control standards appropriate for the generality of new and existing A2 installations in the Ceramics sector.

These installations require a permit to operate in accordance with the 2000 Regulations under what is known as the Local Authority-Integrated Pollution Prevention and Control (LA-IPPC) regime. Local authority regulators are required by regulation 37 to have regard to this guidance. The Secretary of State / WAG will also treat this guidance as one of the material considerations when determining any appeals made under the Regulations against a local enforcing authority decision.

1.3 The guidance also (where appropriate) gives details of any mandatory requirements affecting emissions and impacts from these installations, which are in force at the time of publication. These include requirements contained in directions from the Secretary of State / WAG.

1.4 This is one of a series of such guidance notes aimed at providing a strong framework for consistent and transparent regulation of LA-IPPC installations.

1.5 General guidance explaining LA-IPPC and setting out the policy and procedures, is contained in the "General Guidance Manual on Policy and Procedures for A2 and B Installations" (**Ref 2**) available from **www.defra.gov.uk/environment/ppc/index.htm**, to be referred to in this document as the "General Guidance Manual." This is designed for operators and members of the public, as well as for local authority regulators.

Best Available Techniques (BAT)

1.6 BAT is the main basis for determining standards in LA-IPPC. This sector guidance note addresses what is considered by the Secretary of State/WAG to constitute BAT for Ceramic activities.

As made clear in chapter 12 of the General Guidance Manual, BAT for each installation should be assessed by reference to the appropriate sector guidance note, and these notes should be regarded by local authorities as their primary reference document for determining BAT in drawing up permits. In general terms what is BAT for one installation is likely to be BAT for a comparable installation. However, determination of what is BAT is ultimately a matter for case-by-case decision taking into account that individual circumstances may affect BAT judgements and what are the appropriate permit conditions.

Thus, for each ceramic installation, local authorities (subject to appeal to the Secretary of State / WAG) should regard this guidance note as a baseline, but ensure they take into account any relevant case-specific factors such as the individual process configuration and other characteristics, its size, location, and any other relevant features of the particular installation. Further guidance on this, including the issue of taking account of operators' individual financial position, is contained in chapter 12 of the General Guidance Manual.

1.7 If there are any applicable mandatory EU emission limits, these must be met, although BAT may go further. The same applies to UK regulations, except that, in reconciling BAT with the Control of Pollution (Oil Storage) (England) Regulations 2001, SI 2954, it may be acceptable to achieve an equivalent level of control to that specified in the 2001 regulations (although the oil storage regulations do not apply in Wales, they should be regarded as an indication of BAT in Wales)[1].

[1] Further guidance on the Oil Storage Regulations, if needed, is available from www.environment-agency.gov.uk/osr

Who is this guidance for?

1.8 This guidance is for:

- local authority regulators: who must have regard to the guidance when determining applications and when regulating installations which have a permit
- operators: who are best advised also to have regard to it when making applications and in the subsequent operation of their activities
- members of the public: who may be interested to know what standards are envisaged for the generality of installations in this sector.

1.9 The guidance is based on the state of knowledge and understanding of installations in this sector, their potential impact on the environment, and the available control techniques at the time of writing. The guidance may be amended from time to time in order to keep abreast with developments, including improvements or changes in techniques and new understanding of environmental impacts and risks. Any such amendments may be issued in a complete revision of this note, or in separate additional guidance notes which address specific issues. (N.B. It may not always be possible to issue amending guidance quickly enough to keep in absolute step with rapid changes, which might be another justification in particular cases for diverging from this note.) Steps will be taken to ensure that those who need to know about changes are informed of any amendments. Operators (and their advisers) are, however, strongly advised to check with the relevant local authority whether there have been any amendments before relying on this note for the purposes of applying for a permit or making any other decisions where BAT and related matters may be a consideration.

Terminology

1.10 In addition to the General Guidance Manual referred to above, explanation or clarification of certain terms used in this sector guidance note may be found in a general guidance note issue under Part I of the Environmental Protection Act 1991: 'Interpretation of terms used in process guidance notes', known as General Guidance Note 4 - GG4 - published by HMSO in 1991. Where there is any conflict between GG4 and the guidance issued in this note or in the General Guidance Manual, the latter two documents should prevail, as should any subsequent guidance issued in relation to LA-IPPC.

Installations covered

1.11 This note covers installations, described in Section 3.6 Part A(2) of Schedule 1 to the PPC Regulations as follows:

"Unless falling within Part A(1) of this Section, manufacturing ceramic products (including roofing tiles, bricks, refractory bricks, tiles , stoneware or porcelain) by firing in kilns, where:

(i) the kiln production capacity is more than 75 tonnes per day; or

(ii) the kiln capacity is more than $4m^3$ and the setting density is more than $300kg/m^3$."

The A1 listing for ceramics is almost the same except it only captures installations where "a reducing atmosphere is used other than for the purposes of colouration" (so making Fletton bricks is A1)

1.12 The installation includes the main activities as stated above and associated activities which have a technical connection with the main activities and which may have an effect on emissions and pollution.

1.13 The following definitions may be useful.

- Kiln capacity – the capacity of a kiln would be the maximum useable space. A simple measure of useable space may be the volume of the smallest cuboid that encloses both the product and any kiln furniture used when setting the product. For tunnel kilns only the firing zone is counted towards the capacity.

- Setting density – calculated from kiln capacity and weight of unfired i.e. green product excluding kiln furniture.
- Kiln production capacity – installation capacity is an aggregate of individual capacities (limited by the occupational constraints specified in the description of the installation). Capacity for batch production is averaged over the time taken to fire a batch.
- Multiple firings – should not be counted each time when calculating the production capacity for the installation. Production capacity should be based on:
  - (i) the amount of finished, saleable product that could be produced in a day (taking account of any agreed operational constraints) irrespective of the number of firings.
  - (ii) Plus any material lost in the first firing.

1.14 This guidance note addresses the following aspects of the prescribed installation,

Heavy clay products include:

- Clay bricks, including clamps and scotch Kilns
- Roof tiles and heavy clay floor tiles
- Vitrified clay pipes

Refractory products include:

- Technical ceramics

Calcining clay

Whiteware products include:

- Tableware, cookware and giftware
- Ceramic wall and floor tiles
- Sanitaryware

Review and Upgrading Periods

Existing installations or activities

1.15 Earlier guidance PG3/2(95) Amended by AQ6(99), PG6/42(94), PG3/15(96) and PG3/17(95) Secretary of State's Guidance Notes, relating to emissions to air advised that upgrading to that standard should usually have been completed by a range of dates up to 2000, depending upon the history of the activity. Requirements still outstanding from any existing upgrading programme should be completed.

1.16 The previous version of this guidance, SG07(04) contained improvements that were required to be completed over a range of dates up to 2014. These were listed in Table 1 of the Note. Where a date or time period in the note has been passed then installations should be upgraded to these standards by the date of publication of this note.

1.17 The new provisions of this note and the dates by which compliance with these provisions is expected, are listed in **Table 1** below, together with the paragraph number where the relevant guidance is to be found. Compliance with the new provisions should normally be achieved by the dates shown. Permits should be drafted having regard to this compliance timetable.

(1) Where this guidance note specifies provisions which are additional to, higher than or different to those in PG3/2(95) Amended by AQ6(99), PG6/42(94), PG3/15(96) and PG3/17(95), and SG07(04), only in exceptional circumstances should upgrading of existing installations and activities having regard to these additional/higher/different provisions be completed later than the compliance date specified in **Table 1** below.

(2) Where standards or provisions in PG3/2(95) Amended by AQ6(99), PG6/42(94), PG3/15(96) and PG3/17(95) and SG07(04) have been deleted in this guidance note or where this guidance note specifies less stringent provisions than those in PG3/2(95) Amended by AQ6(99),

PG6/42(94), PG3/15(96) and PG3/17(95) and SG07(04), the new LAIPPC permit should reflect this straightaway.

Table 1: Compliance requirements

Guidance	Reference	Compliance Date
All new filtration plant – Design specification to operate to an emission standard of less than10mg/m^3	3.16	On commissioning
New silos – to be fitted with automatic protection systems	BAT19	On commissioning
Delivery to silos from road vehicles should only be made by tankers with an onboard (truck mounted) relief valve and filtration system or an alternative agreed technique must be used.	BAT 16	1 April 2007
Arrestment equipment discharging externally with exhaust flow >300m^3/min, other than that serving kilns or silos, has an emission limit of 50mg/m^3. There is a requirement for continuous monitoring and recording of the emissions.	Table 4 : (Heavy clay)	1 April 2006
All new and replacement arrestment plant, other than that serving kilns or silos, should be designed to achieve the limit of 50mg/m^3 for particulate matter when functioning correctly.	Table 4: (Heavy clay)	Prior to installation
All new or replacement silo filtration plant should be designed to operate to an emission standard of less than 10mg/m^3 for particulate matter.	Table 4 : (Heavy clay)	Prior to installation
Particulate matter – Drier, calciner 50mg/m^3	Table 4 (Calcining clay)	1 January 2009
Particulate matter – Post – 1995 pulveriser drier 50mg/m^3	Table 4 (Calcining clay)	1 January 2009
Chloride – Scrubbed emissions 10mg/m^3	Table 4 (Calcining clay)	1 January 2014 [1]
Fluoride – Calciner 5mg/m^3	Table 4 (Calcining clay)	1 January 2014 [1]
BS 3405 replaced by BS ISO 9096 Sampling points on **new** plant to meet BS ISO 9096 requirements		On commissioning
[1] This date will be reviewed in the light of any research into compliance with emission limit values for chloride and fluoride emissions, with a view to considering whether compliance can and should be achieved earlier than 1/1/2014. This review may coincide with the review of the whole of this guidance following publication of the BREF		
Particulate matter emission limit of 50 mg/m^3 for sand and mineral drying plant	Table 4 : (Mineral drying and cooling)	1 April 2006
Where, by virtue of burning waste oil, the EU Waste Incineration Directive applies, the WID limit values and other parameters must be taken to supersede those contained in this guidance note	Table 4 : (Oil burning)	To meet the requirements of the Waste Incineration Directive

(unless these are more stringent) in relation to the waste incineration activity		
Arrestment plant (other than that serving mineral drying plant or silos) handling dry dust which discharges externally with exhaust flow greater than $100m^3$/min, should be designed to achieve an emission limit for particulate matter of $50mg/m^3$	Table 4 : (Mineral drying and cooling)	Where 50 mg/m^3 design criteria can be designed into existing plant, by the use of higher grade replacement filters or different scrubber liquor flow rates or packing media for example, then this should be complied with as soon practicable, which in most cases should be by 1 April 2005. New or replacement plant should be designed to this specification prior to installation.
New arrestment plant with an external exhaust flow greater than $100m^3$/min (other than that serving mineral drying plant or silos) should be **designed** to achieve an emission limit of $50mg/m^3$ for particulate matter	Table 4 : (Mineral Drying and cooling)	
Emissions to water	Table 5 :	1 April 2005
Raw Material / Waste minimisation	Bat 92	1 October 2005
Odour assessment	BAT 79	1 April 2007
Environmental Management Systems	3.205 BAT 81	1 April 2008
Competent person for public liaison	BAT 86	1 April 2007
Formal structure for environmental control and training	BAT 87 & 88	1 April 2008
Review of raw materials	Bat 91	Within 18 months of the issue of the permit
Water efficiency audit	BAT 95	Within 18 months of the issue of the permit
Waste annual review	BAT 101	1 April 2007
Energy audit	BAT 103	Within 12 months of the issue of the permit
Accident prevention plan	BAT 111	1 April 2007
All Other Requirements		To be complied with as soon as practicable, which in most cases should be within 12 months of the publication of this note

1.18 Replacement plant should normally be designed to meet the appropriate standards specified for new installations or activities.

New installations or activities

1.19 For new installations or activities - from the first day of operation the permit should have regard to the full standards of this guidance.

Substantially changed installations or activities

1.20 For substantially changed installations or activities - as from the first day of operation, the permit should normally have regard to the full standards of this guidance with respect to the parts of the installation that have been substantially changed and any part of the installation affected by the change.

Permit Reviews

1.21 Permits should be reviewed in accordance with the guidance in chapter 26 of the General Guidance Manual. The review frequencies given in that chapter are considered appropriate for activities and installations covered by this sector guidance note.

Summary of Releases

Table 2: Summary of releases – Heavy clay and refractory products

Source / Releases	Blending	Loading and unloading	Raw material Stockpile	Hardstandings and storage areas. Roadways including Haulage ways	Vehicle bodies and wheels	Material Transfers, charges and discharges including hoppers, conveyors, silos and sheds	Size reduction	Driers (product)	Kiln emissions	Wet scrubbers	Dry scrubbers	Waste oil combustion	Waste oil Storage	Waste water treatment	Wet body preparation	Refractory impregnation with pitch
Particle matter / Total suspended solids	A	A	A	A	A	A	A	A	A			A		W	W	
Oxides of sulphur								A	A		A	A				
Fluorides									A	A	A					
Chlorides									A	A	A	A				
Oxides of nitrogen								A	A			A				A
VOC									A							A
Dioxins												A				
Odour									A			A	A			A
Solid waste or sludge											L					
Liquid effluent										W						
Noise		*	*				*	*								

KEY

A – Release to Air, W - Release to Water, L – Releases to Land, * - Noise release.

Table 3: Summary of releases – Ceramics whiteware

Source → / Releases ↓	Blending	Loading and unloading	Raw material Stockpile	Hardstandings and storage areas. Roadways including haulage ways	Vehicle bodies and wheels	Material Transfers, charges and discharges including hoppers, conveyors, silos and sheds	Size reduction	Driers	Kiln emissions	Wet scrubbers	Dry scrubbers	Glaze preparation	Glazing	Waste water treatment	Wet body preparation
Particle matter / Total suspended solids	A	A	A	A	A	A	A	A	A		A	W	W	W	W
Oxides of sulphur								A	A		A				
Fluorides									A	A	A				
Chlorides									A	A	A				
Oxides of nitrogen								A	A						
VOC									A						
Odour									A						
Solid waste or sludge											L				
Liquid effluent										W					
Noise		*	*				*	*							
Lead												WL	WL	WL	
Cadmium												WL	WL	WL	
Cobalt												WL	WL	WL	
Boron												WL	WL	WL	
Zinc												WL	WL	WL	

KEY
A – Release to Air, W - Release to Water, L – Releases to Land, * - Noise release.

2 Emission limits and other provisions

2.1 This section contains emission limits, mass release rates and other requirements that are judged for the generality of the activities within the sector to represent BAT.

Emissions to air associated with the use of BAT

2.2 Concentration limits are only applicable to contained emissions exhausted to external atmosphere.

2.3 The emission limits expressed as concentrations should not be applied to individual kilns with a net rated thermal input averaged weekly of less than 2MW, or to existing clamps or scotch kilns. Thus, if a process comprises two kilns each of 15 MW and three kilns each of 1.5MW, the two large kilns should be subject to the emission limit, but the smaller kilns would not. The net rated thermal input should be calculated for each kiln on the basis of the average hourly input in megawatts taken over the time the kiln is in operation each week. (The operating cycle for batch processes, as described in the process description, is the cycle which takes the kiln load from ambient temperature up to top temperature and back to ambient temperature.

2.4 The requirement for no visible emissions applies to all kilns other than clamps and scotch kilns.

Table 4: Emissions to air associated with the use of BAT

Determined	Source	Limits	Monitoring	Monitoring Frequency
			Subject to paragraphs 3.245-3.261	
Silos				
Particulate matter	Silo inlet and outlets	No visible emission	Operator/Driver Record start and finish times	Observations every delivery
Heavy clay and refractory goods except clamps and scotch kilns				
Particulate matter	Kilns with a net rated thermal input of 2MW or more	100mg / m^3	Isokinetic monitoring	Annually
Particulate matter	Kilns with a net rated thermal input of less than 2MW	No visible emission	Operator observations	At least daily when the kiln is in operation
Particulate matter	All emissions to air	No visible emission	Operator observations	At least daily
Particulate matter	Fugitive emissions – Whole site	No visible emission	As agreed with the regulator – to ensure that the dust control measures are working	As agreed with the regulator
Particulate matter	Arrestment equipment [1] with exhaust flow >300m^3 / min (other than from kiln or silo arrestment plant)	50 mg / m^3	Continuously recorded indicative monitoring Isokinetic sampling	Continuous At least once to demonstrate compliance, then as necessary to provide reference for the continuous inductive monitor

Particulate matter	Arrestment equipment [1] with exhaust flow >100m^3 / min <300m^3 / min (other than from kilns and silo arrestment plant)	Designed to achieve 50 mg / m^3	Continuous indicative monitoring to demonstrate that the arrestment equipment is functioning properly	Continuously
Particulate matter	Arrestment equipment [1] with exhaust flow < 100m^3 / min (other than silo arrestment plant)	No visible emission	Operator observations **OR** Continuous indicative monitoring to demonstrate that the arrestment equipment is functioning properly	At least daily Continuously
[1] Where the plant discharges to the external atmosphere				
Nitrogen oxides [2]	All new or substantially changed processes (with a net rated thermal input of 2 MW or more)	500 mg / m^3	Manual extractive testing	Annually
[2] For nitrogen oxides, the value to be monitored should either be the sum of the concentration of nitric oxide and nitrogen dioxide, or the concentration of nitric oxide alone to which is added an agreed increment, established by analysis, to represent the appropriate proportion of nitrogen dioxide.				
Chloride (expressed as hydrogen chloride)	All new or substantially changed processes (with a net rated thermal input of 2 MW or more)	50 mg/m^3	Manual extractive testing	Annually
Fluoride (expressed as hydrogen fluoride)	All kilns with a net rated thermal input of 2 MW or more	10 mg / m^3	Manual extractive testing	Annually
Sulphur oxides (expressed as sulphur dioxide)	New or substantially changed plant (with a net rated thermal input of 2 MW or more) Where low sulphur clays are used (< / =0.12% w/w sulphur)	500 mg / m^3	Manual extractive testing	Annually
Sulphur oxides (expressed as sulphur dioxide)	New or substantially changed plant (with a net rated thermal input of 2 MW or more) Where high sulphur clays are used (>0.12% w/w sulphur)	2000 mg / m^3	Manual extractive testing	Annually
Heavy clay goods – clamps and scotch kilns Clamps and scotch kilns do not have chimneys, so it is impossible to monitor pollutant concentrations in the emissions which are direct to atmosphere. The limits to be applied to clamp and scotch kiln operations should be equivalent to the requirements of the Clean Air Act 1993 and the statutory nuisance provisions of Part III of the Environmental Protection Act 1990				
Whiteware Kilns over 2 MW				
Whiteware Kilns with a net rated thermal input over 2 MW should apply the limits in 'Heavy clay and refractory goods except clamps' in this Table				
Whiteware Kilns under 2 MW				
Particulate matter	Kilns with a net rated thermal input of less than 2 MW	No visible emissions	Operator observations	At least daily
Whiteware site including all plant				
Particulate matter	Fugitive emissions – Whole site	No visible emissions	As agreed with the regulator – to ensure that the dust control measures are working	As agreed with the regulator
Particulate matter	All authorised emissions points	No abnormal emission	Operator observations	At least daily

Calcining clay and spray drying				
Total particulate matter	Drier, calciner	50 mg / m^3	To comply with BS ISO 9096	Twice a year
Total particulate matter	Pre-1995 pulveriser drier	100mg / m^3	To comply with BS ISO 9096	Twice a year
Total particulate matter	Post-1995 pulveriser drier	50 mg / m^3	To comply with BS ISO 9096	Twice a year
Total particulate matter	All authorised emission points	No abnormal emission	Operator observations	At least twice daily
Total particulate matter	Arrestment equipment * with exhaust flow > 300 m^3 / min	50 mg / m^3	Continuously recorded indicative monitoring	Continuously
Total particulate matter	Arrestment equipment * with exhaust flow > 100 m^3 / min	No visible emission. Equipment should be designed to achieve 50mg / m^3	Continuously recorded indicative monitoring to demonstrate equipment is functioning correctly	Continuously
Total particulate matter	Arrestment equipment * with exhaust flow > 100 m^3 / min	No visible emission	Operator observations **OR** Continuous indicative monitoring to demonstrate that the arrestment equipment is functioning properly	At least daily Continuously
* Where discharge is to external environment (other than that serving dryers, calciners or silos)				
Chloride (expressed as hydrogen chloride)	Emissions that have been scrubbed using chloride compounds.	10 mg / m^3	BS EN 1911	Twice a year
Total Fluoride (expressed as hydrogen fluoride)	Calciner	5 mg / m^3	ISO DIS 15713	Twice a year
Mineral drying and cooling				
Total particulate matter	Sand and mineral drying plant	50 mg / m^3	Either monitoring in accordance with the main procedural requirements of BS 1SO 9096 **OR** Monitoring in accordance with the main procedural requirements of BS ISO 9096 plus continuously recorded indicative monitoring	6 monthly **OR** Annually plus continuous
Total particulate matter	All authorised emission points	No abnormal emissions	Operator observations	At least daily
Total particulate matter	Arrestment equipment * with exhaust flow > 300 m^3 / min	Designed to achieve 50 mg / m^3	Continuously recorded indicative monitoring	Continuously
Total particulate matter	Arrestment equipment * with exhaust flow > 100 m^3 / min	Designed to achieve 50 mg / m^3	Continuous indicative monitoring to demonstrate that the arrestment equipment is functioning properly	Continuously
Total particulate matter	Arrestment equipment * with exhaust flow = / < 100 m^3 / min	No visible emission	Operator observations **OR** Continuous indicative monitoring to demonstrate that the arrestment equipment is functioning properly	At least daily **OR** Continuously
• Other than that serving silos or mineral driers with external discharge points				

Oil burning				
Waste or recovered oil burning. Where by virtue of burning waste oil, the EU Waste Incineration Directive applies, the WID limit values and other parameters must be taken to supersede those contained in this guidance note (unless these are more stringent) in relation to the waste incineration activity. See guidance about the Waste Incineration Directive				
Petroleum pitch impregnation of refractories				
Petroleum pitch fume, as cyclohexane extractable fraction	All processes involving the heating of petroleum pitch excluding incinerators and storage	50 mg m^3	Manual Extractive test with filter at or below 42°C. See Notes on measuring petroleum pitch fume.	Annual
	Petroleum pitch incinerators	Minimum temperature of 800ºC with a residence time of at least 0.5 seconds	From incinerators, bitumen monitoring is not required as long as time and temperature of secondary combustion is monitored and recorded along with visual and audible alarms	Annual calibration
Note on petroleum pitch incinerators	In normal operation should be free from visible smoke. In no circumstances should emissions exceed the equivalent of Ringelmann Shade 1, as described in BS 2742:1969 For some incinerators at these conditions, smuts and odours may still be a problem, in which case an increase of temperature up to 1000ºC may be needed			

Benchmark emissions to water associated with the use of BAT

2.5 Limit values for water discharges will be specified in individual cases taking account of the receiving environment. Wastewater treatment systems can maximise the removal of metals using precipitation, sedimentation and possibly filtration. It is also practicable in many cases to re-use treated water. **Table 5** provides information regarding achievable levels associated with the use of wastewater treatment systems for discharge to surface water.

Table 5: Emissions to water associated with the use of BAT

Determinand	Benchmark release concentration, mg/l
For heavy clay and refractory goods, and whiteware	
Suspended matter	0 – 60
BOD	0 - 40
Oil	0 - 5
Additionally for whiteware	
pH	6 – 10
Temperature	ambient, but less than 43C
Pb	10
Zn	20
The appropriateness of the above release concentrations will vary dependent on the sensitivity of the receiving waters and should be proportionate to the scale of the operation.	

3 Techniques for pollution control

3.1 This section summarises, in the outlined BAT boxes, what BAT should be in most circumstances. The boxes should not be taken as the only source of permit conditions; compliance with emission limits and other provisions contained in this guidance note together with any relevant case-specific considerations will also need to be taken into account.

3.2 The standards cover the techniques and measures which, in combination with those in the relevant previous (LAPC/IPC/Waste) guidance, have been identified as representing BAT in a general sense. They also cover the other requirements of the Pollution Prevention and Control (England and Wales) Regulations 2000 and requirements of other regulations, such as the Waste Management Licensing Regulations and the Groundwater Regulations insofar as they are relevant to an IPPC Permit. For the sake of brevity these boxes simply use the term "BAT".

3.3 Where techniques or operating conditions are referred to in the BAT boxes below, provided that it is demonstrated to the satisfaction of the regulator that an equivalent or better level of control of environmental impacts will be achieved, then other techniques or operating conditions may be used.

Installation description and in - process controls

3.4 The meaning of “installation” and “directly associated activity” is addressed in chapter 2 of the General Guidance Manual.

3.5 This section contains an overview of the ceramics sector, which considers processes in general, and lists the ceramic processes

The subsectors are listed below. ‘Bulk powdered material transfer including Silos’ is dealt with first as it is common to all subsectors

- Bulk powdered materials transfer including silos
- Heavy Clay
- Clay brick and roof tile manufacture
- Brick making in clamps
- Vitrified clay pipes
- Refractory products
- Tableware, cookware, giftware
- Ceramic tiles
- Sanitaryware
- Spray drying of ceramics
- Mineral drying and cooling

Each subsector is described giving:

- The process and their controls
- The significance of additional environmental impacts
- BAT box

Text common to all subsectors then restarts as Emissions control 3.169

3.6 The installation covers one of more activities listed in Schedule 1 of the PPC Regulations plus directly associated activities that are both technically connected and can have an effect on pollution. The full definition of installation is given and explained in the GENERAL Guidance Manual.

Overview of ceramic industries

3.7 A2 ceramic installations fit into the following subsectors:

- Heavy clay products are covered by this guidance note, including
  — Clay Bricks, including clamps
  — Roof tiles and heavy clay floor tiles
  — Vitrified clay pipes

- Refractory products are covered by this guidance note including technical ceramics
- Whiteware is covered by this guidance note, can includes
  — Tableware and ornamental ware
  — Sanitary ware
  — Ceramic wall and floor tiles

For information,

- The UK A1 ceramics industry consists mainly of Fletton brick manufacture, which uses Lower Oxford clay usually in Hoffman kilns. Reducing conditions are needed to control the rate of combustion of the higher carbon content of the clay.
- Any A2 installations that become A1 because they also carry out a specified waste activity will use this guidance together with the appropriate guidance for the waste activity.

General Processes

3.8 Diverse raw materials, natural and synthetic, are used to produce a wide range of ceramic goods using various production techniques. Installations may be sited at the source of a raw material. The wide variation in products, material used for particular products, and production methods, lead to widely varying levels of consumption and emission.

3.9 Despite the wide variation in materials, products and their properties, and production methods, ceramic manufacture can be split into the following processes, though different processes are omitted for different materials and products.

Raw material preparation, including mixing

Raw material preparation

- Drying
- Pre-blending
- Weathering / Souring
- Primary and secondary grinding and screening
- Dry or wet milling
- Dry screening / air classification
- Spray drying
- Calcining
- Synthetic base materials
- Frits and Glazes. Glaze preparation
- Storage and feeding of raw materials

Component mixing

- Continuous mixers
- Batch mixers

Forming and shaping of ware

- Hand forming
- Pressing
- Extrusion
- Moulding
- Slip casting
- Fusion casting

Decoration

- Texturing
- Applied facings
- Engobing and glazing

Drying ware

- Hot floor dryers
- Chambers dryers (intermittent)
- Chambers dryers (Continuous)
- Vertical “basket” dryers
- Horizontal multi deck roller dryers

- Dehumidifying dryers
- Tunnel dryers

Firing of ware
- Intermittent (periodic) Kilns
- Continuous Kilns: chambers
- Continuous Kilns: tunnel
- Roller hearth kilns
- Sliding bat kilns
- Clamps
- Scotch kilns

Product Finishing
- Machine
- Wet Grinding
- Drilling
- Sawing
- Polishing
- Carbon enrichment (refractories)
- Tumbling of facing bricks

Addition of auxiliary materials
- Jointing materials (pipes)
- Silicones / water repellents
- Lightweight plastic (refractory bricks)
- Adhesives
- Sorting Packaging and storage

Subsectors/Processes

Bulk powdered material transfer inc Silos

3.10 Powdered materials are delivered by road or rail in Bulk tankers, or by water in barges or ships. The powder materials are transferred through a closed system of heavy duty hoses to storage silos, using compressed air as a carrier medium. Silos are vented to allow air to escape through filters, so controlling dust emission

3.11 The delivery of powder from road tankers relies on a compressor (blower) mounted on the tanker lorry providing a supply of air which is used in three ways:
- To pressurise the tank vessel with air so that inside the vessel there is significant pressure which helps feed the powder out of the tankers. The tank is pressurised at the start of the blow, and can be repressurised as necessary during the course of discharging.
- A separate feed from the air supply passes to the distributor system which fluidises the powder around the distributor plate.
- A third feed of air receives fluidised powder and flows from the tanker, along the connecting pipework and into the silo. The powder fed from the distributor system is thus transferred to the silo in the air stream.

3.12 The flow of air/material through the pipe depends on the pressure in the blowing line and hence the pressure in the tankers. The pressure required to successfully convey the powders is determined by the resistance to flow and gravity that is to be overcome which varies depending upon the height to which the powders are to be pumped (i.e the height of the silo) and the pipe length and diameter.

3.13 The tanker discharge is controlled by the tanker driver. The driver controls the flow of air to the tank, the distributor and the silo to maintain a constant flow of material into the silo without exceeding the flow capacity of the filter system or exerting excessive pressure in the silo (which is not a pressure vessel).

3.14 In the event that the silo becomes pressured the pressure relief valve should lift for safety reasons. If the pressure relief valve in not designed to relieve the pressure quickly enough, the silo may rupture or the filter unit may be ejected from the top of the silo. Such incidents give rise to an unacceptable emission to atmosphere. Such incidents have been caused by excessive pressure being blown from the delivery tanker into the silo at the end of the delivery cycle.

3.15 Venting the residual air from a tanker should be via a flow restrictor, which limits the rate at which the air is discharged through the silo. Rather than venting through the silo, it is preferable that residual air should be vented to atmosphere using a filtered vent on the tanker.

3.16 All new silos should be designed to operate to an emission standard of $10 mg/m^3$

3.17 If the filter system on the silo is not capable of handling the large flow of air that is generated during the delivery process, this may cause an increase in pressure within the silo. Filter manufacturers supply information on the pressure drop across filters and the filtration rate. It is important that the filter size is calculated to match the flow rates of air through the silo. The filter systems must be cleaned to prevent blockages and accumulation of powder in the filter system.

3.18 During silo filling it is most likely that any emissions would be released during the first and last five minutes of the delivery. The first few minutes is when emissions due to leak or split hoses would first be noticed. The last few minutes is when excess pressure from the tanker may cause an emission through the pressure relief valve if the driver is not controlling the delivery correctly. During silo filling procedures isokinetic monitoring of emissions from the arrestment plant is not likely to be possible as the delivery period is so short. For this reason there is no numerical emission limit for such plant. It is important however that the plant is designed to cope with the delivery flow rate that is used for the silo.

3.19 Silo systems require appropriate inspections and assessments to minimise potential for emissions during the filling process.

3.20 Reduced inspection frequency of silos may be appropriate:

a) Where pressure drop sensors or other continuous monitors are used to monitor the arrestment plant; such monitors should be inspected according to manufacturers recommendations to ensure their proper operation.
b) For filters fitted with reverse jets or with mechanical shakers where operating experience has demonstrated satisfactory operation of the arrestment plant
c) Where the process is infrequent.

3.21 Careful delivery by trained personnel will avoid materials being blown into silos at a rate which is likely to result in pressurisation of the silo, especially towards the end of the delivery when the quantity of materials entering the ducting is reduced

3.22 Continuous high level monitoring systems are currently available and in use in storage silos. They may be used telemetrically to monitor stock within the silo. They may also be used to automatically stop delivery of material to the silo. The silo management system includes high level alarms, arrestment plant and pressure relief valve. Use of alternative techniques may be acceptable provided that they achieve an equivalent level of control with regard to potential for emissions to air.

Environmental impact

Water:	Not significant
Land:	Not significant
Air:	Particulate matter in delivery air emitted
Waste:	Not significant
Energy:	Not significant
Accidents:	over-pressurisation can lead to silo rupture, filter failure or filter housing ejection

Noise: Delivery blowers can be noisy

BAT
The operators should 1 Inform tanker drivers of the correct procedures to be followed concerning noise, spillage, leaks and dusty emissions emissions 2 Ensure that visual assessment of emissions from silo inlet connections and the silo arrestment plant are undertaken throughout the duration of all bulk deliveries. 3 Record the start and finish times of all deliveries 4 Inspect silo arrestment plant and arrestment plant serving other process at the frequency specified in Table 6: 5 Check the outlet for signs that emissions have occurred. 6 Check the equipment for defects in the air flow or the cam shakers. If emissions or defects are detected then corrective action should be taken promptly and before another delivery takes place. Any Failure of the silo management system (e.g. high level alarms, filter, pressure relief valve) should lead to full investigation of the operation of the plant and equipment. 7 Store all dusty or potentially dusty materials in silos, in confined storage areas within buildings, or in fully enclosed containers / packaging. Where the storage is open within a building, then suitable precautions should be taken to prevent wind whipping. 8 During delivery to a silo or bulk storage tank, either vent displaced air to suitable arrestment plant (for example cartridge/bag filters) or backvent it to the delivery tanker, in order to minimise emissions. 9 Ensure arrestment plant fitted to silos is of sufficient size (and kept clean) to avoid pressurisation during delivery. 10 In order to minimise fugitive emissions during the charging of silos, ensure that the transfer lines are securely connected to the silo delivery inlet point and the tanker discharge point, in that order. 11 Equip bulk storage tanks and silos containing dry materials with audible and/or visual high level alarms, or volume indicator, to warn of overfilling. 12 Check the correct operation of such alarms weekly or before a delivery takes place, whichever is the longer interval. 13 Cease silo filling if emissions of particulate matter are visible from ducting, pipework, the pressure relief valve or dust arrestment plant during silo filling; rectify the cause of the problem prior to further deliveries taking place. 14 Check the seating of pressure relief valves on silos at least once a week, or before a delivery takes place, whichever is the longer interval. 15 Prevent further deliveries immediately it appears that the pressure relief valve has become unseated during silo filling, no further delivery should take place until corrective action has been taken. Examine the pressure relief valve to check for defects before re-setting, and fit a replacement valve if necessary. 16 Ensure deliveries to silos from road vehicles are only made using tankers with an on-board (truck mounted) relief valve and filtration system. 17 During the period of upgrading, take particular care to avoid pressurisation of silos when venting air through the silo at the end of the delivery, if deliveries are accepted from tankers without on board relief valve and filtration systems.

18 Take care to avoid delivering materials to silos at a rate which is likely to result in pressurisation of the silo. Particular care is required towards the end of the delivery when the quantity of material entering the ducting is reduced and hence the air flow is increased.

19 Fit all new silos with an automatic system to cut off delivery in the event of pressurisation or overfilling.

Table 6: Frequency of visual inspection

Filters	Frequency of visual inspection
Fitted with reverse jets	At least once a month
Fitted with mechanical shakers	At least once a week
Requiring manual shaking	Daily inspection or prior to any delivery being made if deliveries are not daily

Heavy Clay

Clay brick and roof tile manufacture

3.23 Clay brick and roof tile etc. manufacture is often sited next to the clay pit. Water collecting in the pit is discharged to stream or sewer. Only if the discharge is part of the installation is the water discharge subject to the permit.

3.24 Clay winning may be performed on an annual basis to provide clay for the year's production or on an intermittent or continuous basis. It is stored in compacted stockpiles. Dust emissions to the air are negligible when winning due to the natural water content of clay. However, the movement of clay and stock piling may, particularly in dry weather, result in drying and disintegration. Measures such as water spraying may be necessary to prevent, or, where that is not practicable, to minimise dust emissions to the air.

3.25 Consideration should be given to the siting of stockpiles, based upon such factors as the prevailing winds, proximity of site boundary and proximity of neighbours. Minimisation of drop height is very important in stockpiling to reduce wind whipping of particulates.

3.26 Clay is dug from the stockpile and tipped into a receiving hopper. Transfer to the factory may be by conveyor, in which case exposed sections should be covered or enclosed. An optional clay store may provide a strategic reserve of material under cover. When designing storage bays, internal walls separating storage bays should be at least ½ metre lower than external walls of the bays. Clay may be fed from the clay store, using (for example) a front end loading shovel, to a box feeder for conveyance into the clay preparation area.

3.27 There are various ways of keeping conveyor belts and the surrounding areas clean. Where chevron belts are used catch plates may be fitted to contain dust falling from the underside of the belt at the turning point. From a health and safety perspective this is not always possible and hoses and sprinklers are a possible alternative. New conveyors can be designed to minimise free fall at discharge points. A chute, of similar equipment, at the point of discharge from a conveyor reduces dust arising.

3.28 Clay is discharged into the clay preparation area where it is first of all fed into a primary grinding process (which may involve the addition of water). It may then be conveyed for further processing through medium and high speed rolls.

3.29 Dust from the grinding plant is extracted to bag filters and cleaned air is exhausted to the atmosphere or returned back into the factory (provided COSHH requirements are met).

3.30 The clay from the preparation plant in conveyed via a surge control feeder to mixers where it is adjusted to the required moisture content by the addition of water as necessary. Materials may also be added at this stage either to improve the clay workability for subsequent processing or as a colourant. It then passes to the shaping operation.

3.31 If the shaping is by extrusion (extrusion / wire cut process) the material is passed through a extruder where it is formed into a column. The extruder clay column is cut by wires into individual wet units. These may then receive a variety of surface textures and surface blasted sanded colours. Where sand blasting takes place this is carried out within an enclosed cabinet and dust-laden air is extracted to bag filter units.

3.32 If shaping is by moulding, (soft mud processes) the material mix contains a higher degree of moisture. It is first of all divided into clots which are slightly larger than the resulting unit and these clots are either thrown or dropped vertically into a series of moulds which may contain sand and colourants. Optionally, the mould may be subject to a very light pressure which removes the texture produced by entering the mould. The mould is then trimmed to remove surplus clay mix and the unit is then demoulded.

3.33 If the shaping is by pressing, the material mix is placed into the pressing chamber, which may contain sand and colourants, and subjected to a pressure adequate to form a coherent body and is then demoulded.

3.34 The clay ware is loaded onto dryer cars and placed into drying chambers or a tunnel dryer. Dryers are heated using clean, hot air recovered from the cooling zone of the kiln where tunnel kilns are in use, and natural gas fired heaters make the temperature up to approximately 120 ºC. Drying usually takes place over approximately a 24 hour period, but it can be longer where materials are sensitive to the rate of drying. The emissions from the dryers consist of water vapour which is exhausted to atmosphere via stacks situated at least 3m above the roof ridge height.

3.35 Once dried, the units are progressed to a setting station (which may be a machine) where they are loaded ready for firing. In modern automated plant this involves the use of kiln cars which are then positioned in the kiln for firing. The kiln may be a tunnel type, which gives rise to a continuous firing process as cars join a “train of cars” and move through the kiln. Otherwise the kiln may be of a continuous chambers type where the units remain stationary and the fire moves around the kiln. In either case some degree of equilibrium is reached in the firing process and therefore the flow of exhaust gases is relatively stable in terms of temperature, composition and volume.

3.36 It is possible for firing to be of an intermittent type which is conducted in batch or shuttle kilns. Firing takes place from ambient temperature up to top firing temperature and back to ambient temperature over a period which may be as long as 3 days of more. The Operational cycle of an intermittent kiln comprises both the heated and cooling processes. This type of firing is in sharp contrast with the steady state conditions of the continuous kiln. In this case the profile of the kiln exhaust flow will be markedly different during the various stages of the firing and cooling cycle. Different criteria are therefore appropriate when considering regimes for monitoring and measurements of these processes.

3.37 Kiln gases may be treated to reduce the hydrogen fluoride content before being emitted to atmosphere via a high stack, commonly about 25 metres, if the kiln is above the thermal input threshold of 2 MW.

3.38 After firing the units and the kiln is unloaded. They are inspected for quality and packed, ready for despatch.

3.39 Emissions from the process operations covered by this note comprise nitrogen oxides (from combustion) fine particulate matter, sulphur oxides, chlorides and fluorides. The control of dust emissions from process handling operations is mainly by the use of enclosures. Containment and arrestment is generally preferred to dust suppression techniques. The potential for fugitive emissions is reduced by minimising airborne dust from internal transport. Emissions from combustion may be controlled by the use of low NOx burner technology and low sulphur fuels. Fluoride emissions are controlled by in furnace process optimisation or by the use of scrubbers.

3.40 Process modifications may be made to control fluoride emissions to comply with or approach emissions limit values. Alternatively, when used in conjunction with abatement, process optimisation may reduce the cost and use of abatement and its raw materials and waste. Process optimisation involves the optimum selection of one or more primary measures. (see **Ref 8**)

- Kilns which have emissions in the range 10-30 mg/m³ before any process optimisation measures have been taken are reasonably likely to achieve an emission limit value of below 10 mg/m³ when such measures are applied, but this is not guaranteed.
- The likelihood of process optimisation measures achieving 10 mg/m³ of below from a starting point of 30-50 mg/m³ is much less.
- It is not envisaged that any plant would achieve 10 mg/m³ or below from a starting point over 50 mg/m³

3.41 Primary measures to reduce fluoride emissions include:

- Increasing the length of the kiln preheat section which increases the absorbtion capacity of the zone.
- Altering the time – temperature profile. As this is already used to adjust production capacity, it may not be reliable for abatement.
- Air flow. Controlling and directing the air flow can allow more time for reabsorbtion of HF back into the product
- Setting patterns. Open setting patterns alter the absorbtion and emission of HF
- Including body additives which can react with HF to prevent its re-emission, or lower the vitrification temperature which shortens the firing cycle, or dilute the fluoride content of the body.

Environmental impact

Water: Claypit drainage, but only if it is part of the installation

Land: Not significant

Air: Fluoride, particulate matter, odour, products of combustion

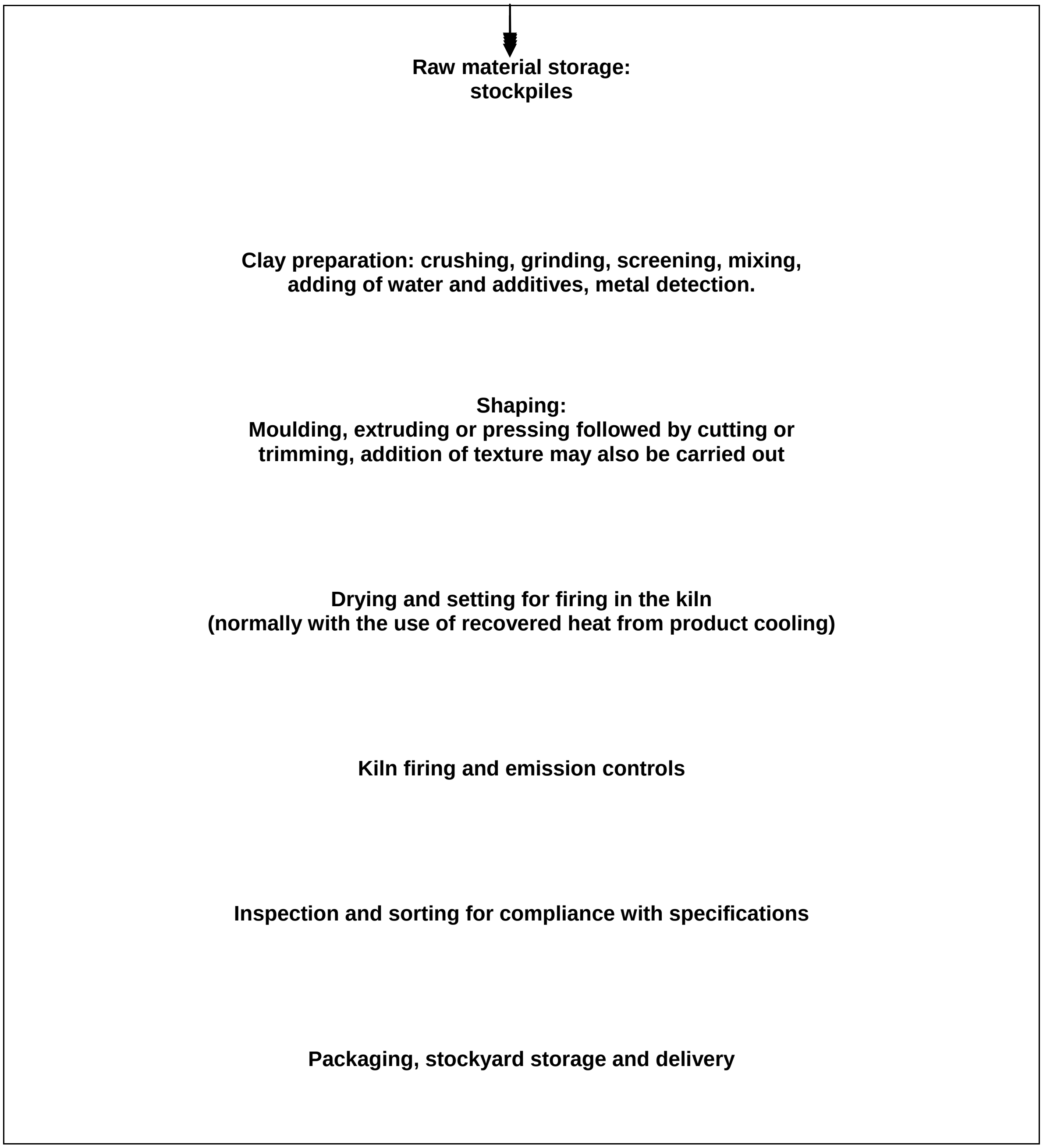
Waste: Not significant

Energy: Significant

Accidents: Not significant

Noise: Material preparation and transport

Figure 1: Flow diagram of a typical clay brick manufacturing process



BAT
Stockpiles and ground storage Operators should 20 Ensure that, where there is vehicular movement, storage areas have a consolidated surface which is kept in good repair. 21 Use storage bays where practicable to control dust emissions. Stock should not be piled higher than the external walls of the bay and should not be put forward of the bay. 22 Wet stockpiles where necessary to minimise dust emissions. Install fixed water sprays for long term stocking areas if appropriate. 23 Where dusty materials are conveyed, provide adequate protection against wind whipping of the conveyor and any transfer points. **Conveying** The operator should 24 Fit conveyors with means for keeping the belt clean 25 Not overload conveyor belts 26 Where the free fall of material gives rise to external dust emissions, use techniques at the point of discharge to minimise this. 27 Include conveyor systems in planned preventative maintenance schedules. **Process operations** The operator should 28 Fit all crushing, grinding screening or drying plant with an efficient means for the control of dust emissions to meet the emission limits. 29 Minimise the flow of air through crushing, grinding or screening plant. 30 Minimise the free fall of the product.

Brick Making in clamps

3.42 A clamp is a kiln. A clamp does not have a chimney, so it is impossible to monitor pollutant concentrations in the emissions which are direct to atmosphere

3.43 A clamp is a traditional method for the firing of clay bricks supplying a niche market for authentically produced bricks for use in listed buildings and conservation projects. They are also used in distinctive new projects where a traditional appearance is paramount.

3.44 A clamp may contain as many as 2 million bricks, though some are smaller than this. Each brick contains colourant as an integral part of the body. Typical colourants are coke breeze, town ash, pulverised fuel ash (fly ash or PFA), furnace bottom ash, froth flotation fines. The sulphur content of the colourants should be known. It is typically 2% or below for coke breeze.

3.45 The base of the clamp is formed by two or more layers of bricks on edge on the ground. The firing method is to use thin layers of coke in between layers of green (unfired) bricks. Additional heat input may be via gas fired lances inserted into the body of the clamp at low level.

3.46 The whole mass is encased in a layer of bricks (two bricks thick). Once the coke layers have been ignited the clamp will fire gradually – some processes may take as long as 10 weeks, although many take only some three weeks. The rate of control of the burning is either by the use of gas fired lances or by controlling the amount of air entering the clamp. Either method is less effective at controlling the burn rate than modern tunnel kiln technology

3.47 The exhaust from the clamp is directly to atmosphere and ambient air quality standards are used to assess the acceptability of the process, as well as the requirements of the Clean Air Act 1993.

3.48 Emissions tend to be most odourous at the start of the burn. Controls can include staggering the start of the burn, limiting the sulphur in the colourants and thoroughly air drying the green brick. Clamps are often roofed and may have some walls.

3.49 Offsite monitoring is sometimes needed.

Environmental impact

Water:	Claypit drainage, but only if it is part of the installation
Land:	Not significant
Air:	Fluoride, particulate matter, sulphurous odour, smoke, products of combustion
Waste:	Not significant
Energy:	Significant
Accidents:	Not significant
Noise:	Materials preparation and transport

BAT
No additional BAT is specified for clamps. Include any relevant BATs from the other BAT boxes plus BAT derived from Clean Air Act and ambient air quality standards

Scotch Kilns

3.50 A scotch kiln has no chimney so it is impossible to monitor pollutant concentrations in the emissions that are direct to atmosphere.

3.51 There are thought to be around 16 scotch kilns at four sites in the Chilterns and Suffolk, producing traditional bricks in the local style.

3.52 Scotch kilns, like clamps, have no chimney. Scotch kilns do have walls of refractory brick, typically three feet thick reinforced with steel girders, and firing ports along each long side. Increasingly the fuel used is gas oil. They have a dismountable roof of planks. Capacity is typically 60,000 to 100,000 bricks per kiln.

3.53 The unfired brick body contains colourant, (the colourant is typically 3% anthracite with a sulphur content typically 0.25 – 0.65%).

3.54 The unfired bricks are stacked in the kiln, and covered with partly fired bricks (splatter bricks). The stacking pattern and position in the kiln largely determine the brick colour. Firing with oil starts gradually and builds up to maximum input after about 24 hours. At this stage the oil burners are removed and the fire holes are stopped up. The rising heat transferring from brick to brick completes the firing over a further 2 days or so, and then start to cool. Three or more days after this the bricks can be unstacked.

3.55 The exhaust from the kiln is directed to atmosphere and ambient air quality standards are used to assess the acceptability of the process, as well as the requirements of the clean air act 1993.

3.56 Controls include limiting the sulphur content in the colourant and the fuel.

BAT
No additional BAT is specified for scotch kilns. Include any relevant BATs from the other BAT boxes plus BAT derived from Clean Air Act and ambient air quality standards

Vitrified Clay Pipes

3.57 Vitrified clay pipe manufacture is often sited next to clay quarries. Water collecting in the quarries is discharged to stream or sewer after filtration and settlement through site lagoons. If the discharge is part of the installation then the water discharge is permitted

3.58 Clay winning is performed on an intermittent or a continuous basis to provide clay for the year's production. It is stored on open storage sheds prior to blending into compact stockpiles. Dust emissions to the air are negligible when winning due to the natural water content of clay. A water spray must be necessary to keep the surface of the open stockpile damp in the dry weather.

3.59 Clay is extracted from the stockpile and tipped into a receiver hopper. It is crushed and transferred to the blending area for formation into plant specific clay stockpiles. It is first of all fed into a primary grinding process (which may involve the addition of water). It may then be conveyed for further processing treatment where further grinding and blending with inert filters takes place. Transfer of materials may be by conveyor, in which case exposed sections are covered or enclosed.

3.60 Dust from grinding plant, and other raw material processing operations is extracted to bag filters and cleaned air is exhausted to the atmosphere or returned back into the factory (provided COSHH requirements are met).

3.61 For traditional blue clay, processing may now be complete, but for fast firing processes, calcining will further treat the clay blend. The clay will be partially fired (at 650 ºC) to remove impurities and then reground and blended prior to use. The emissions from this plant are treated to reduce particulates utilising electrostatic precipitation and cyclone filtration.

3.62 Additional blue and calcined clay stores may provide a strategic reserve of materials under cover or in enclosed silos. Clay may be fed from these stores, using (for example) a front end-loading shovel, or for calcined material pneumatic conveying.

3.63 Clay from the raw material plant is conveyed via covered road vehicles or pneumatic conveyor systems to local store hoppers prior to use. Local exhaust ventilation systems are fitted to local storage facilities. This clay stock is fed to mixers where it is adjusted to the required moisture content by the addition of water if necessary, Materials may also be added at this stage such as colourants, aesthetic improvers or materials to increase the tolerance of the material to the subsequent firing. It then passes to the extrusion or forming operation.

3.64 Extrusion. Material is passed through an extruder where it is formed into a tube. To aid passage through the extruder the clay may be lightly oiled. If formed into a complex shape the uses of die lubricant may be adopted. Wires cut the extruded clay into individual green items. These may then receive additional trimming or compaction to improve product quality.

3.65 Pressing. The material mix contains a higher degree of moisture. It is first of all divided into ”clots” which are slightly larger than the resulting unit and these clots are placed into a series of moulds. The mould may be subject to pressure, which removes the marks produced by the mould. The mould is then trimmed to remove surplus clay mix and the unit is then demoulded.

3.66 The green product is loaded onto the kiln cars and placed into drying chambers or a tunnel dryer. In the roller kilns, the green product is placed on a roller dryer and continuously dried. Dryers are heated using clean, hot air recovered from the cooling zone of the kiln and natural gas fired heaters. Drying can take several hours, but can be longer where materials are sensitive to the rate of drying, the emissions from the dryers consist of water vapour and particulate that are exhausted to atmosphere via stacks situated at least 3m above the roof ridge height.

3.67 Once dried, the product progresses to a setting station (which may be a machine) where they are loaded ready for firing. In modern automated plant this involves the use of kiln cars which are then positioned in the kiln for firing, the kiln may be a tunnel type, which gives rise to a continuous firing process as cars join a “train of cars” and move through the kiln. Otherwise the kiln may be of a continuous chamber type where the units remain stationary and the fire moves around the kiln. In either case some degree of equilibrium is reached in the firing process and therefore the flow of exhaust gases is relatively stable in terms of temperature, composition and volume.

3.68 Calcined clay products pass through a roller kiln, here the product is pushed through the kilns sat on pushers and moved by a moving chain.

3.69 If it is possible for firing to be of an intermittent type, which is conducted in batch, or shuttle kilns. Firing takes place from ambient temperatures up to top firing temperature and back to ambient temperature over a period, which may be several days or more. The operational cycle of an intermittent kiln comprises both the heating and cooling process. This type of firing is in sharp contrast with the steady state conditions of the various stages of the firing and cooling cycle. Different criteria are therefore appropriate when considering regimes for monitoring and measurements of these processes.

3.70 After firing the units are cooled and the kiln is unloaded. They are inspected for quality and packed, ready for dispatch.

Stockpiles and ground storage

3.71 Clays usually contains sufficient moisture to prevent problems of emissions of dust to the atmosphere when removed from the quarry. However the movement of clay and stockpiling may, particularly in dry weather, result in drying and disintegration. Measures such as water spraying may be necessary to prevent, or, where that is not practicable, to minimise dust emissions to the air.

3.72 Consideration should be given to the siteing of stockpiles, based upon such factors as the prevailing winds, proximity of site boundary and proximity of neighbours. Minimisation of drop height is important in stockpiling to reduce wind whipping of particulates.

3.73 These are various ways of keeping conveyor belts and the surrounding areas clean. Normal plain trough conveyor belts are used to transport materials around the site, where external these belts are covered and at the termination points a scrapper plate is fitted to remove any impacted material. Covered catch plates may be fitted to contain dust falling from the underside of the belt at the turning point. New conveyors can be designed to minimise free fall at discharge points. A chute, or similar equipment, at the point of discharge from a conveyor reduces dust arising.

Process operation

3.74 Emissions from the process operations covered by this note comprise nitrogen oxides (from combustion), fine particulate matter, sulphur oxides, chlorides and fluorides. The control of dust emissions from process handling operations is mainly by the use of enclosures. Containment and arrestment is generally preferred to dust suppression techniques. The potential for fugitive emissions is reduces by minimising airborne dust from internal transport. Emissions from combustion may be controlled by the use of low NOx burner technology and low sulphur fuels. Fluoride emissions are controlled by in furnace process optimisation or abatement.

3.75 Process modifications may be made to control fluoride emissions to comply with or approach emission limit valves. Alternatively, when used in conjunction with abatement, process optimisation may reduce the costs and use of abatement and its raw materials and waste. Process optimisation involves the optimum selection of one or more primary measures. (see **Ref 8**)

- Kilns which have emissions in the range 10-30 mg/m³ before any process optimisation measures have been taken are reasonably likely to achieve an emission limit value of below 10 mg/m³ when such measures are applied, but this is not guaranteed.
- The likelihood of process optimisation measures achieving 10 mg/m³ or below from a starting point of 30-50mg/m³ is much less
- It is not envisaged that any plant would achieve 10 mg/m³ or below from a starting point of 50 mg/m³

3.76 Primary measures to reduce fluoride emissions include

- Increasing the length of the kiln preheat section which increases the absorbtion capacity of the zone
- Altering the time – temperature profile. As this is already used to adjust production capacity, it may not be reliable for abatement
- Air flow, controlling and directing the air flow can allow more time for reabsorbtion of HF back into the product.
- Setting patterns. Open setting patterns alter the absorbtion and emission of HF
- Body additives can react with HF to prevent its re-emission, or lower the vitrification temperature which shortens the firing cycle, or dilute the fluoride content of the body.

Potential Environmental impact

Water:	Claypit drainage, but only if it is part of the installation
Land:	Not significant
Air:	Fluoride, particulate matter, sulphurous odour, smoke, products of combustion
Waste:	Not significant
Energy:	Significant
Accidents:	Not significant
Noise:	Materials preparation and transport

BAT
No additional BAT is specified for this subsector. Use all relevant BATs from other BAT Boxes including BAT 20-30

Refractory products

High temperatures refractory products

3.77 The principle raw materials are magnesia (magnesium oxide) and doloma (calcined and sintered dolomite). These purchased materials are stored in bulk before being crushed and screened as two distinctively separate product streams. Different grades of each are used to manufacture different products.

3.78 The components of a specific formulation, including small quantities of additives and a binder, are discharged into a mixer. Refractory mixing is a batch operation.

3.79 Complete mixes are transferred to the feeder hopper of large hydraulic presses, with operating pressures up to 5 GPa. A variety of metal mould designs permit the production of a wide range of refractory brick shapes and sizes.

3.80 The pressed (green) refractory bricks then undergo heat treatment. Resin and carbon bonded products are subject to low temperature (250 – 300 ºC) tempering in a continuous, indirect fired kiln process. Fired basic, dolomite and sliding gate components undergo high temperature firing, within a 1455 – 1640 ºC firing range. Both continuous tunnel kilns and intermittent kilns are used. All heating processes are natural gas fired.

3.81 After heat treatment, products may be involved in further processing before final packing and storage ready for dispatch. Further processing may involve sizing, colour coding, labelling, plating, carding, cutting, drilling and grinding.

3.82 The products are used primarily for steel and cement making processes

Manufacture of refractory shapes using pitch

3.83 The manufacture of impregnated refractory shapes typically involves the preheating of the refractory bricks before placing them in a heated vessel which is then evacuated and filled with petroleum pitch. Impregnation is completed by blanketing with nitrogen under pressure. When the cycle is complete, surplus petroleum pitch is pumped back to storage. The refractory shapes are cooled before being fired in ovens for several hours. Finally, the shapes are shotblasted to remove surplus carbon from the refractory surface.

Potential Environmental impact

Water:	Not significant
Land:	Not significant
Air:	Fluoride, particulate matter, odour, products of combustion
Waste:	Not significant
Energy:	Significant
Accidents:	Not significant
Noise:	Materials preparation and deliveries

BAT

Use all relevant BATs from other BAT Boxes including BAT 20-30

31. The operator should ensure that: petroleum pitch fume from the pitch impregnated autoclave and the cooling of the pitch impregnated product is contained and incinerated

Tableware cookware and giftware

3.84 Although the manufacture of ceramic tableware, cookware and giftware is intrinsically the same process for all manufacturers, there are differences depending upon the type of ceramic body produced and the methods of forming, glazing and decoration used.

- Body preparation
- Forming
- Biscuit firing
- Glazing
- Glost firing
- Decoration
- Enamel firing
- Inspection & packing

3.85 Ceramic tableware bodies are manufactured from a combination of raw materials, which includes clay, feldspars, sands, flint, alumina, bone ash and metallic oxide colourants. The actual ingredients and proportion of each depending upon the type of ceramic i.e porcelain, bone china, stoneware or earthenware being produced.

3.86 The raw materials are supplied either loose, bagged or in slop form and are stored prior to use in the manner most appropriate for the materials and site.

3.87 The raw materials are apportioned and mixed with water to form a homogeneous suspension (body slip). The mixing processes carried out by the most appropriate method for the raw materials and product type. Normal methods are either by high-speed mixer (blunger) or ball mill.

3.88 The body slip is usually beneficiated by sieving to remove coarse particles and passing over magnets to remove ferrous materials that may cause specking problems in the finished articles

3.89 Before the clay body can be used for forming it must be partially de-watered. The method of forming an article from clay body will determine the method of de-watering employed and the physical form in which the clay body is used. Clay articles are formed from:

- Plastic Clay
- Casting Slip
- Clay Granulate

3.90 **Plastic Clay** body slip is pumped at high pressure into a filter press, which contains a series of cavited filter plates covered by filter cloths. Here the body slip is converted into plastic body, in the form of flat-sectioned press-cakes, by the removal of some of the water. (Plastic clay contains approximately 22% water). Wastewater from this process is usually either recycled of settled before discharge.

3.91 Before this plastic clay can be used to make ware, the clay must first be de-aired and then compacted into a homogenous body. A machine called a ‘pug mill’ carries out this process. The press-cake are fed into the pug mill where they are shredded into small pieces. A vacuum is applied to the clay which removes any air that is trapped in it and then the clay is compacted together and extruded from the machine in long ‘sausage’ shaped pieces of clay known as pug rolls.

3.92 **Casting Slip** is made by mixing together plastic clay, water and a mixture of chemicals, known as deflocculants, in a blunger, to produce a clay slip with a much higher density i.e. a higher solids content, than normal body slip. (Casting slip contains approximately 28% water). (Casting slip can be prepared directly from the body raw materials thus removing the need for the filter pressing stage).

3.93 **Clay Granulate** Body slip with high solids content is spray dried to produce clay granulate with the required particle size characteristics and water content of approximately 2%.

3.94 **Machine Making** ‘Slugs’ of plastic clay, cut from a pug roll, are either placed into (in the case of holloware, such as cups and casseroles) or onto (for flatware, such as plates and saucers) a porous mould usually made of plaster of Paris. The mould is then rotated as depending upon the particular machine, a revolving or static metal tool is applied to the clay so that it squeezes the clay and forces it to assume the combined shape of the tool and the mould. The ware is then partially dried to a condition known as ‘leather-hard’ to enable it to be released from the mould and to ensure that it is rigid and strong enough to be touched by either machine or hand.

3.95 **Ram Pressing** Slices of plastic clay are pressed under high pressure between two halves of a porous plaster of Paris mould to form a clay article. The article is removed when the press is opened and then dried to the ‘leather-hard’ stage.

3.96 **Casting** A porous plaster of Paris mould is filled with casting slip and then left for a short period of time, usually about 15 minutes. In this time, the casting slip thickens and water from it is absorbed by the mould, forming a thin layer of clay in contact with the inside surface of the mould. Once the layer of clay has reached the required thickness, the excess slip is poured out of the mould and the mould is left, upside down, to drain so that a smooth finish inside the piece is produced. When the mould has finished draining, the piece is trimmed with a sharp knife to remove any excess clay from around the top of the mould and the ware is allowed to dry inside the mould.

3.97 Once the piece has dried sufficiently to allow it to be carefully handled without breaking or deforming, it is removed from the mould and dried further to the leather-hard stage.

3.98 **Pressure Casting** High-density body slip is pumped under high pressure into a porous die resulting in the partial removal of water from the slip. When the die is opened the solid clay article produced is removed and dried to the 'leather-hard' stage.

3.99 **Isostatic Pressing** Clay granulate is fed pneumatically into a die assemble in its relaxed, open mode. The die itself will consist of a front face of steel or plastic together with a rear section made from flexible polyurethane membrane. When the die is full, isostatic compaction takes place to approximately 300 bar by the application of hydraulic pressure to the rear membrane. After forming the die opens to release the item.

3.100 Once the article has been formed in clay and dried to the 'leather hard' stage it is finished by removal of any seams and rough edges by fetting and sponging. All trimmings and damage pieces are usually recovered and recycle up to the white hard stage.

Biscuit firing

3.101 Dried clayware is placed onto a kiln for its first firing, which is usually known as the biscuit fire. Specific firing conditions are dependant upon the type of ceramic ware produced and the type of kiln used.

3.102 Kilns may employ either a continuous or an intermittent firing process. In the continuous firing process either a continually moving 'train of cars' or a conveyor of some type passes through a kiln that is continually firing. In this case a degree of equilibrium is reached in the firing process and therefore the flow of exhaust gases is relatively stable in terms of temperature, composition and volume.

3.103 With intermittent kilns, firing takes place from ambient temperatures up to top temperature and back to ambient temperature during the firing period. The operational cycle of an intermittent kiln comprises both heating and cooling processes. This type of firing is in sharp contrast with the steady state conditions of the continuous kiln. In this case the profile of the kiln exhaust flow will be markedly different during the various stages of the firing and cooling cycle. Different criteria are therefore appropriate when considering regimes for monitoring and measurement of these processes.

3.104 After firing the ware is cooled and the kiln is unloaded. They are inspected for quality and passed on to the next process.

Glazing

3.105 Glaze is a mixture of finely ground glassy materials and other minerals that are suspended in water. A thin layer of the unfired glaze is applied to the biscuit or clayware piece either by dipping the piece into the liquid glaze or spraying the glaze onto the ware.

3.106 Any glaze overspray is usually recovered and recycled. Wash-down water is usually settled or filtered to remove solids prior to discharge.

Glost firing

3.107 The dried glazed ware is fired in a kiln to melt the glaze and so form a hard, thin glassy layer, which covers the ware. As with biscuit firing the firing process may take place in either continuous or intermittent kilns. The firing conditions are dependent upon the type of ware produced, type of kiln and type of glaze used.

Decorating

3.108 The method employed to decorate ware and the point in the production process are numerous and are dependent upon the nature of the product.

3.109 The point at which the ware is decorated can be:

- On the clayware
- On the biscuit ware
- On the unfired glaze
- On the glost ware

3.110 The decorating techniques employed include:

- Hand painting
- Direct screen printing
- Total transfer printing
- decalcomania

Enamel firing

3.111 When decorating has been applied onto glost ware the ware then undergoes a further kiln firing, usually known as the enamel fire. Again this kiln firing can be either continuous or intermittent kilns.

Inspection and packing

3.112 The ware is then inspected for quality and packed ready for dispatch

Process Controls

3.113 Even where there are no numerical limits on emissions from table-, cook-, and giftware kilns, the following guidance on minimising emissions indicates control techniques that are possible. In the proposed review of this guidance, the following 3 paragraphs will be reassessed to see which, if any, of the techniques should be considered as BAT.

3.114 Emissions from the process operations covered by this note comprise nitrogen oxides (from combustion), fine particles matter, sulphur oxides, chlorides and fluorides. The control of dust emissions from process handling operations is mainly by the use of enclosures. Containment and arrestment is generally preferred to dust suppression techniques. The potential for fugitives emissions is reduced by minimising airborne dust from internal transport. Emissions from combustion may be controlled by the use of low NOx burner technology and low sulphur fuels. Fluoride emissions are controlled by in furnace process optimisation or by the use of scrubbers.

3.115 Process modifications may be made to control fluoride emissions to comply with or approach emission limit values. Alternatively, when used in conjuction with abatement, process optimisation may reduce the cost and use of abatement and its raw materials and waste. Process optimisation involves the optimum selection of one or more primary measures. (see **Ref 8**)

3.116 Primary measures to reduced fluoride emissions include

- Increasing the length of the kiln preheat section which increases the absorbtion capacity of the zone.
- Altering the time – temperature profile. As this is already used to adjust production capacity, it may not be reliable for abatement.
- Air flow. Controlling and directing the air flow can allow more time for reabsorbtion of HF back into the product.
- Setting patterns. Open setting patterns alter the absorbtion and emission of HF
- Including body additives which can react with HF to prevent it's re-emission, or lower the vitrification temperature which shortens the firing cycle, or dilute the fluoride content of the body.

Potential Environmental impact

Water:	Heavy metals, particulate matter
Land:	Not significant
Air:	Fluoride, particulate matter, odour, products of combustion
Waste:	heavy metals, fired and unfired solids
Energy:	Significant
Accidents:	Not significant
Noise:	Materials preparation and transport

BAT

Stockpiles and ground storage

Operators should

32. Ensure that, where there is vehicular movement, storage areas have a consolidated surface which is kept in good repair.

33. Use storage bays where practicable to control dust emission. Stock should not be piled higher than the external walls of the bay and should not be forward of the bay.

34. Wet stockpiles where necessary to minimise the dust emissions. Install fixed water sprays for long term stocking areas if appropriate.

35. Where dusty materials are conveyed, provide adequate protection against wind whipping of the conveyor and any transfer points.

Conveying

The operator should

36. Fit conveyors with means for keeping the belt clean.

37. Not overload conveyor belts.

38. Where the free fall material gives rise to external dust emissions, use techniques at the point of discharge to minimise this.

39. Include conveyor systems in planned preventative maintenance schedules.

Process operations

The operator should

40. Fit all crushing, grinding, screening or drying plant with an efficient means for the control of dust emission limits.

41. Minimise the flow of air through crushing, grinding or screening plant.

42. Minimise the free fall of the product.

Ceramic tiles

3.117 Dependant on the type of ceramic body produced, there are differences between the process methods for ceramic tiles. The production process can be broken down into the following key elements:

- Body preparation
- Forming
- Drying
- Glazing
- Firing
- Additional decorating (in some cases)
- Inspection and packing

3.118 Ceramic tile bodies are produced from a combination of raw materials which include clays, silica, limestone, feldspars and recycled ceramics. Actual ingredients and their proportions will vary depending on the type of body i.e. wall tiles, unglazed floor tiles or glazed floor tiles or glazed floor tiles being produced.

3.119 The raw materials are supplied in bulk, either by road tanker, or by loose deliveries e.g. from tipper or skip. Storage varies with the material and the site. E.g. fired wastes in outdoor uncovered yard, silos for fine dusts and some other materials

3.120 The raw materials are appointed and mixed together in either dry form or in the suspension in water. The harder minerals are ground in the water in ball mills either separately or together with all the body materials. Ball mills are either continuous or batch processed.

3.121 The body slip is sieved to remove coarse particles and passed over magnets to remove ferrous materials that may cause “specking” problems in the finished products.

3.122 The clay body is usually converted to a granulate with a moisture content of below 10% and required particle size distribution by spray drying. This granulate is then stored in silos prior to being fed, by conveyors, to tile presses.

Forming

3.123 Clay granulate is fed mechanically into a die assembly consisting of steel or polyurethane covered steel face and rear dies. When the cavity of the die assembly is full of granulate, compaction takes place automatically by application of hydraulic pressure. The pressure applied can vary significantly depending on the type of tile being manufactured. After pressing, the die opens and the tiles are automatically ejected. Once the tile has been formed it is then dried to remove the majority of the residual moisture.

Glazing and Decorating

3.124 Some hot tiles exit directly from the drier to the glazing lines. Unglazed floor tiles go directly from drying to the firing kilns

3.125 In many cases an engobe is applied to the tiles prior to glazing. An engobe is a thin buffer layer between the tile body and the glaze and this consists of glass frits, clay and other minerals. The glaze is a mixture of finely ground glasses, other minerals and, in some instances, calcined metal oxide pigments. Both the engobe and glaze are applied as liquid suspensions by either passing the tiles on belts through waterfalls or by spraying.

3.126 Various methods are then used to apply decorative patterns to the glaze surface. The prints are usually in the form of thick paste of calcined metal oxide pigments in a medium such as polyethylene glycol. Patterns are usually applied by transferring pigment through a mesh onto the tile e.g. through a silk screen.

3.127 Any excess glaze, print materials and wash-down water is collected and treated prior to discharge.

Firing

3.128 The glazed tiles are then conveyed and fed into kilns for firing. Kilns can either be intermittent kiln or continuous tunnel, or most commonly, single layer roller hearth kilns. During firing the glaze melts to form an impervious glass layer over the surface of the tile. The firing conditions vary depending on the type of tiles being produced, type of kilns and type of glazes and decorations.

3.129 In some cases additional decorations are applied to the fired glaze surface. This is most commonly done by screen printing or lithography. When such a decoration has been applied, the tiles undergo a further firing. Again this firing can either be in continuous or intermittent kilns.

Inspection and Packing

3.130 The fired tiles are inspected for quality and packed ready for despatch.

Process Controls

3.131 Even where there are no numerical limits on emissions from tile kilns, the following guidance on minimising emissions indicates control techniques that are possible. In the proposed review of this guidance, the following 3 paragraphs will be reassessed to see which, if any, of the techniques should be considered as BAT.

3.132 Emissions from the process operations covered by this note comprise nitrogen oxides, sulphur oxide, chlorides and fluorides (from firing) and fine particulate matter. The control of dust emissions from process handling operations is mainly by the use of enclosures. Containment and arrestment is generally preferred to dust suppression techniques. The potential for fugitive emissions is reduced my minimising airborne dust from internal transport. Emissions from combustions may be controlled by the use of low NOx burner technology and low sulphur fuels. Fluoride emissions are controlled by in furnace process optimisation or by the use of by the use of scrubbers.

3.133 Process modifications may be made to control fluoride emissions to comply with or approach emission limit values. Alternatively, when used in conjunction with abatement, process optimisation may reduce the cost and use of abatement and its raw materials and waste. Process optimisation involves the optimum selection of one or more primary measures. (see **Ref 8**)

3.134 Primary measures to reduce fluoride emissions include:

- Increasing the length of the kiln preheat section which increases the absorbtion capacity of the zone.
- Altering the time – temperature profile. As this is already used to adjust production capacity, it may not be reliable for abatement.
- Air flow. Controlling and directing the air flow can allow more time for reabsorbtion of HF
- Including body additives which can react with HF to prevent its re-emission, or lower the virtification temperature which shortens the firing cycle, or dilute the fluoride content of the body.

Potential Environmental impact

Water:	Heavy metals, particulate matter
Land:	Not significant
Air:	Fluoride, particulate matter, odour, products of combustion
Waste:	heavy metals, fired and unfired solids
Energy:	Significant
Accidents:	Not significant

Noise: Materials preparation and transport

BAT
No additional BAT is specified for this subsector. Use all relevant BATs from other BAT Boxes

Sanitaryware

3.135 The Manufacture of sanitary is intrinsically the same process for all manufacturers:

- Body preparation
- Casting
- Drying
- Glazing
- Glost firing
- Inspection
- Re-firing out of spec product
- Finishing, inspection & packing

3.136 There are differences depending upon the methods of casting and glazing used. Plaster moulds may also be manufactured on site.

Plaster Mould Manufacture

3.137 Plaster [gypsum] is delivered in bulk [tote bags] or bagged form. It is weighed out and mixed with water. The plaster mix is poured into a pre-cast mould [made from resin or plaster] and allowed to harden, before removal. Mould drying methods are the same as those for drying of clayware.

Casting Slip Preparation

3.138 Ceramic Sanitary body is manufactured from a combination of raw materials, which includes clays, feldspars/Nephaline Syenite and sands.

3.139 The raw materials are supplied either in dry bulk form or in slop form and are stored prior to use in silos, pens, tanks or arks.

3.140 The raw materials are appointed and mixed with raw water to form a homogeneous suspension (body slip). Usually mixing is by high-speed mixer (blunger) or ball mill. Deflocculants are added.

3.141 The body slip is sieved and magneted. Slip returns from the casting process are re-blunged, clay body scraps are added to the virgin slip.

Casting

3.142 A porous plaster mould is filed with casting slip and then left for a short period of time, usually about 45 minutes. In this time, the casting slip thickens and water from it is absorbed by the mould, forming a layer of clay in contact with the inside surface of the mould. Once the layer of clay has reached the required thickness, the excess slip is poured out of the mould.

3.143 Once the piece has hardened sufficiently to allow it to be carefully handled without breaking or deforming, it is removed from the mould. The mould is dried prior to being re-cast.

Pressure Casting

3.144 High density body slip is pumped under high pressure into a porous die resulting in the partial removal of water from the slip. Casting usually takes less than 10 minutes. When the die is opened the solid clay article produced is removed. The water retained by the mould is removed under pressure and the die is then ready to be re-cast.

Drying

3.145 The moisture from the cast ware is removed prior to being sprayed with glaze. Drying can take place either in open cast shops or batch or tunnel driers.

Glazing

3.146 Glaze is a mixture of finely grounded glassy materials and other minerals that are suspended in water. A thin layer of the unfired glaze is applied to the clayware piece either by handspraying, robotic spraying or high volume machine spraying.

3.147 Any higher density glaze overspray is usually recovered and recycled. Lower density glaze washing can be recycled using micorfiltration techniques.

Glost Firing

3.148 The dried glaze clay ware is fired in a kiln to vitrify the body and melt the glaze which forms a glassy phase over the vitrified body. The firing process may take place in either continuous or intermittent kilns. The firing conditions are dependent upon the type of ware produced and type of kiln. Tunnel and intermittent process description are the same as for tableware.

Re-firing

3.149 Out of specification articles which can be repaired by re-spraying etc are reprocessed and taken through a second firing.

Inspection & Packing

3.150 The ware is then inspected for aesthetic quality and conformance and packed ready for despatch.

3.151 Even where there are no numerical limits on emissions from sanitary ware kilns, the following guidance on minimising emissions indicated control techniques that are possible. In the proposed review of this guidance, the following 3 paragraphs will be reassessed to see which, if any, of the techniques should be considered as BAT.

3.152 Emissions from the process operations covered by this note comprise nitrogen oxides, sulphur oxides, chlorides and fluorides (from firing), fine particulate matter. The control of dust emissions from process handling operations is mainly by the use of enclosures. Containment and arrestment is generally preferred to dust suppression techniques. The potential for fugitive emissions is reduced by minimising airborne dust from internal transport. Emissions from combustion may be controlled by the use of low NOx burning technology and low sulphur fuels. Fluoride emissions are controlled by infurnace process optimisation or by the use of scrubbers.

3.153 Process modifications may be made to control fluoride emissions to comply with or approach emissions limit valves. Alternatively, when used in conjunction with abatement, process optimisation may reduce the cost and use of abatement and its raw materials and waste. Process optimisation involves the optimum section of one or more primary measures. (see **Ref 8**).

3.154 Primary measures to reduce fluoride emissions include:

- Increasing the length of the kiln preheat section which increases the absorbtion capacity of the Zone.
- Altering the time – temperature profile. As this is already used to adjust production capacity it may not be reliable for abatement.
- Air Flow. Controlling and directing the air flow can allow more time for reabsorbtion of HF back into the product.
- Setting patterns. Open setting patterns alter the absorbtion and emissions of HF
- Including body additives which can react with HF to prevent its re-emission, or lower the vitrification temperature which shortens the firing cycle, or dilute the fluoride content of the body

Potential Environmental impact

Water:	Heavy metals, particulate matter
Land:	Not significant
Air:	Fluoride, particulate matter, odour, products of combustion
Waste:	heavy metals, fired and unfired solids
Energy:	Significant
Accidents:	Not significant
Noise:	Materials preparation and transport

BAT
No additional BAT is specified for this subsector. Use all relevant BATs from other BAT Boxes

Drying and calcining of China clay

3.155 China clay is a fine, white, inert powder, the main constituent of which is Kaolinite. It also contains small amounts of fine particle size quartz and mica. It is found in the granite moors of South West England and is mined in Devon and Cornwall. China clay is opencast mined. Once it is exposed a high pressure water jet is fired at the pit face liberating a slurry of china clay, sand and mica. The sand and mica are separated out. The remaining china clay slurry is refined and dried in stages to remove organic matter and other contaminants. A variety of refining processes engineer the shape, size and colour of the production to meet the customer's requirements. It is used predominantly by the paper industry as a filter and as a coating, and in the manufacture of ceramics.

3.156 The different types of product are:

1) As dried – most clay is sold in the form which it emerges from the dryers or tube presses. This consists of clay lumps which may be loaded directly into road, rail, and sea transport or packed into large bags before loading. The moisture content of this product is about 10%.
2) Milled clay – this is a dry powder form. The lump clay is disintegrated in a special milling machine, which also dries the clay to a moisture content of 1%. The powder is packed into dust-tight paper bags.
3) Slurried clay – a thick suspension of clay and water is pumped into the road and rail wagons or specially adapted ships for use by the paper industries.
4) Calcined clay for special products – multi-hearth kilns - if china clay is heated to temperatures above 450ºC its crystalline structure alters and there are improvements in properties such as electrical insulation value and whiteness compared to the original kaolin. The new properties make the product of particular use in the plastics, rubber, paint and concrete industries. The heating process is known as calcination and some clay is treated to make a range of products of particular use in the plastics, rubber, paint and concrete industries.

   China clay to be calcined is usually milled to a fine powder before entering the top of a multihearth calcining kiln. The kiln is a large upright cylinder with a series of hearths heated by gas or oil burners. A central rotating shaft with arms pushes clay down from hearth to hearth passing the clay alternately inwards and outwards so that after about 30 minutes the clay emerges as a calcined product. There is some fusion of particles during the process so that the calcined clay is milled again to a fine powder for use by the customer. In this type of calciner, known as a Herreschoff Kiln, clay is calcined at temperatures from 500ºC to 1100ºC.

One of the novel applications of clay calcined in this kiln is as an additive for concrete to prevent “concrete cancer”

5) Calcined clay for refractory products – tunnel kilns – by heating in a different form of calciner at temperatures from 850ºC to 1500ºC a range of products with outstanding heat resisting properties known as refractories can be prepared. For this process, long heated tunnels are used. Clay is dried in a rotary drier and formed, by machine, into rectangular briquettes. These are placed onto flat wagon and put into a tunnel drier for a period of 32 hours at 240ºC and then into a tunnel calciner for 48 hours at a maximum temperature of 1500ºC. As one wagon comes out of the kiln another goes in and wagons in the tunnel move forward. The tunnel calciner has gas fired burners on either side. During calcination the bricks are converted to a hard refractory product. All fired bricks are crushed and separated into different sized material. Important uses for this product are for making moulds in the investment casting process and to form the small spacing pieces used to separate china items being fired in a potters kiln.

Potential Environmental impact

Water: Clay mining, if it is part of the installation. Effluent from wet scrubbers

Land: Not significant

Air: Fluoride, particulate matter, odour, products of combustion

Waste: Significant if the clay mining is part of the installation

Energy: Significant

Accidents: Not significant

Noise: Milling crushing

BAT
No additional BAT is specified for this subsector. Use all relevant BATs from other BAT Boxes

Spray drying of ceramics

3.157 Spray drying is a process used for the manufacture of ceramics granulates from a ceramic raw material slurry (slip)

3.158 Liquid ceramic bodies comprising ball and china clays, calcined bone and other mineral additives are delivered to site by road tanker or prepared on site from raw materials delivered in bags by road transport and blended in the slip house. The liquid bodies are held as a ceramic slurry and agitated in storage arks prior to spray drying.

3.159 A spray drier is simply a machine for drying an atomised mist direct contact with hot gases. (A hot air stream provided by gas combustion).

3.160 A spray drier consists of a tall, enclosed cylindrical chamber with a means of atomising the slurry and a source of hot air, usually from a gas burner. The ceramic slurry is atomised, either by spinning disc or by pressurised lances, into the hot air stream (500ºC max) within the chamber. The atomised droplets of slurry are rapidly dried as they fall through the chamber to form a ceramic granulate of controlled particle size and moisture content. The granulate is continuously conveyed from the base of the chamber for storage or use.

3.161 The waste gases exhausted from the spray dryer chamber contain fine particles of the materials being dried. Arrestment systems vary but the particles are commonly separated in two stages: first the coarser material is removed by passing the gases through cyclones and then the remaining material is removed using a wet or dry scrubbing system. The waste gases, largely products of combustion and evaporated water vapour, are then emitted to atmosphere.

Potential Environmental impact

Water: Effluent from wet scrubbers

Land: Not significant

Air: Particulate matter, products of combustion

Waste: Not significant

Energy: Significant

Accidents: Not significant

Noise: Some flue noise

BAT
No additional BAT is specified for this subsector. Use all relevant BATs from other BAT Boxes

Mineral Drying and cooling

3.162 Sand drying. When sand is quarried it typically has a moisture content of about 6%. For aesthetic purposes, different quantities of sand are fed into a dryer where it is dried according to requirements. It is then cooled, screened and conveyed via a totally enclosed system to storage.

3.163 Rotary dryers for producing for example 10 tonnes of sand a day tend to be less than a metre in diameter.

3.164 Mineral drying (other than sand) As a result of their porous structure other minerals can have a moisture content up to 30%.

3.165 Arrestment Plant Cyclones, wet scrubbers and bag filters can be used to abate emissions of particulate matter to air.

3.166 Combustion of waste or recovered oil will trigger the application of the Waste Incineration Directive.

3.167 The operator should ensure that deliveries are carried out in such a way so as to avoid noise, spillage, leaks and dusty emissions.

3.168 Storage areas should ideally be under cover and protected from the elements where appropriate to avoid or minimise environmental impact.

Potential Environmental impact

Water: Effluent from wet scrubbers

Land: Not significant

Air: Particulate matter, products of combustion

Waste: Not significant

Energy: Significant

Accidents: Not significant

Noise: Some flue noise

BAT
43. All Bulk storage of dusty materials should be stored in silos, or in confined storage areas within building, or in confined storage areas within buildings, or in fully enclosed containers /packaging. 44. If emissions of particulate matter are visible from ducting, pipework, the pressure relief valve, dust abatement plant or any other part of the plant during silo filling, the operation should cease of the problem rectified prior to further deliveries taking place. Tanker drivers should be informed of the correct procedure to be followed. 45. Transport of dusty materials should be carried out so as to prevent or minimise airborne particulate matter emissions. Double handling of dusty materials should be avoided.

Emissions control

Point source emissions to air

Point source emission to air

3.169 The nature and source of the emissions to air expected from each activity are given in previous sections. In general they comprise:

- Particulate matter from the handling of powders of dusty materials and cutting and finishing operations
- Particulate from spraying glaze
- Fluoride and chloride emitted during firing of products
- Combustion gases from heated processes and kilns
- Occasional odorous compounds from chilled products of combustion from intermittent kilns.

Dispersion and dilution of stack emissions

3.170 The basis upon which stack heights are calculated using HMIP Technical Guidance Note D1 (D1)(**Ref 5**) is that pollutants are dispersed and diluted in the atmosphere to ensure that they ground at concentrations that are harmless under the theoretical conditions of the D1 model. The emissions limits in this sector note should be used as the basis for stack height calculation. The stack height so obtained is adjusted to take into account local meteorological data, local topography, nearby emissions and the influence of plant structure. It is necessary that the assessment also takes into account the relevant air quality standards that apply for the emitted pollutants.

The calculation procedure of D1 is usually to calculate the required stack height but alternative dispersion models may be used in agreement with the regulator. D1 relies upon the unimpeded vertical emissions of the pollutant. A cap or other restriction over the stack impedes the vertical emission and hinders dispersion. For this reason where dispersion is required such flow impeders should not be used. A cone may sometimes be useful to increase the efflux velocity and achieve greater dispersion. An operator may chose to meet a tighter emission limit in order to reduce the required stack height.

Revised stack height calculations should not be required unless it is considered necessary because of a breach, or serious risk of breach, of an EC Directive limit value and because it is clear from the detailed review and assessment work that the Part A2 activity itself is a significant contribution to the problem.

3.171 For kilns under 2 MW for which numerical fluoride limits are not applied, a one-off extractive test to measure HF emissions should be undertaken solely in order to enable a stack height calculation to be made for the purpose of ensuring that the stack height is correct.

3.172 Where an emission consists purely of air and particulate matter, a stack height calculation is not required.

3.173 For intermittent kilns in particular, the exit velocity is dependent on the stage of firing. On existing stacks, where the exit velocity is variable or where it is less than 15 m/sec, this may be acceptable provided that national air quality objectives are not in danger of being breached and the local regulator is satisfied that no other problems are being caused.

3.174 Liquid condensation on internal surfaces of flues and exhaust ducts might lead to corrosion and ductwork failure or to droplet emissions:

- Adequate insulation should be provided to minimise the cooling of waste gases and prevent liquid condensation by keeping the temperature of the exhaust gases above the dewpoint.

3.175 Unacceptable emissions of droplets could possible occur as a result of entrainment from wet abatement plant where the linear velocity within the associated ductwork exceeds 9 m/s. The use of mist eliminators reduces the potential for droplet emissions:

- Where a linear velocity of 9 m/s is exceeded in the ductwork of existing wet abatement plant, the linear velocity should be reduced, subject to health and safety considerations, to ensure that droplet fallout does not occur.

3.176 The dispersion from all emission points to air can be impaired by low exit velocity at the point of discharge. Or deflection of the discharge

- Flues and ductwork should be cleaned to prevent accumulation of materials, as part of the routine maintenance programme.
- A minimum discharge velocity should be required in order to prevent the discharge plume being affected by aerodynamic down wash.

BAT

All releases to air

The operator should:

46. Ensure that all operations which generate emissions to air are contained and adequately extracted to suitable abatement plant, where this is necessary to meet specified emission limits.

47. Ensure that emissions from combustion processes in normal operation are free from visible smoke and in any case do not exceed the equivalent of Ringelmann Shade 1 as described in British Standard BS 2742:1969

48. Ensure that hot emissions take place from the minimum practicable number of stacks, in order to obtain maximum advantage from thermal buoyancy. This is particularly important when new plants are being designed or when changes are being made to existing processes. If practicable a multi-flue stack should be used.

49. Ensure that stack heights are sufficient to ensure adequate dispersion under normal conditions.

50. Ensure that the minimum stack height is 3 metres above roof ridge height of any building within a distance of 5 times the uncorrected stack height and in no circumstances should it be less than 8 metres above ground level.

51. Be able to demonstrate to the regulator that all reasonably practicable steps are taken during start-up and shut down, and changes of fuel or combustion load in order to minimise emissions.

52. Investigate the cause and nature of any persistent visible emissions and provide a report to the regulator.

53. Ensure that emissions of water vapour are free from droplet fallout.

54. Ensure that liquid entrainment in the duct of wet abatement, leading to droplet fallout, does not occur as a result of the linear flow rate within the duct exceeding 9 m/s.

55. Ensure that flues and ductwork are cleaned to prevent accumulation of materials, as part of the routine maintenance programme.

56. Ensure that exhaust gases discharged through a stack achieve an exit velocity greater than 15 m / sec during normal operating conditions to achieve adequate dispersion. Except for intermittent kilns with historical stacks under written agreement by the regulator.

57. Ensure that stacks are not fitted with any restriction at the final opening such as a plate, cap or cowl, with the exception of a cone which may be necessary to increase the exit velocity of the emissions.

Point source emissions to surface water and sewer

3.177 The nature and source of the emissions expected from each activity is given in previous sections. In general, wastewater can arise from storm water, from cooling water, from accidental emissions of raw materials, products or waste materials and from fire fighting.

3.178 Discharges to water and sewer from the Ceramics sector comprise principally from:

- Discharges of boiler water blowdown
- Site drainage and storm water
- Effluent treatment
- Compressor discharges

3.179 The following general principles should be applied in sequence to control emissions to water:

- water use should be optimised and wastewater re-used or recycled
- contamination risk of process or surface water should be minimised
- wastewater treatment systems can maximise the removal of pollutants, for example metals, using precipitation, sedimentation and filtration. The mix of pollutants will define the methods and reagents used. Concentrated effluents should be pretreated as necessary before discharge into the final effluent treatment system
- ultimately, surplus water is likely to need treatment to meet the requirements of BAT (and statutory and non-statutory objectives). Generally, effluent streams should be kept separate as treatment will be more efficient. However, the properties of dissimilar waste streams should be used where possible to avoid adding further chemicals, e.g. neutralising waste acid and alkaline streams. Also, biological treatment can occasionally be inhibited by concentrated streams, while dilution, by mixing streams, can assist treatment
- systems should be engineered to avoid effluent by-passing the treatment plant

3.180 The nature of the receiving water should be taken into account, with regard to any pollutant released to this media. However, irrespective of the receiving water, the adequacy of the plant to minimise emissions must be considered.

Local Authority Regulation

3.181 Regulation 13 of The Pollution Prevention and Control (England and Wales) Regulations 2000 states that:

- "(1) In the case of a Part A installation or Part A mobile plant in relation to which a local authority regulator exercises functions under these Regulations, the Environment Agency may, at any time, give notice to the local authority regulator specifying the emission limit values or conditions which it considers are appropriate in relation to preventing or reducing emissions into water."
- "(3) Where a notice under paragraph (1) specifies conditions in relation to emissions into water from an installation or mobile plant, the permit authorising the operation of that installation or mobile plant, shall include those conditions or more onerous conditions dealing with the same matters as the local authority regulator considers to be appropriate."

Off site effluent treatment

3.182 Where an operator discharges to a Sewage Treatment Works via sewer, the sewerage undertaker is a statutory consultee and must be sent a copy of the application. The STW operator is likely to confirm to the Environment Agency and the local authority the levels of pollutants (considering levels specified in the trade effluent consent) that the sewer is able to take.

In all cases the effluent discharged from the installation must not give rise to a potential breach of an EQS or EAL for the final receiving water, when taken with compliance with any water company permit. In a significant number of cases the Environment Agency finds that the STW operator's discharge consent and the Environment Agency's concerns to protect watercourses are closely aligned. Where they are aligned and there is a simple discharge, it is common Agency practice just to rely on the consent and not to replicate limits in permit conditions.

3.183 For Ceramic activities, although certain effluents can be defined as complex, it is unlikely that BAT equates with tighter limits than those specified by the Environment Agency. Therefore, the consent can be relied upon (as for simple discharges above) without replicating limits in permit conditions.

Further guidance on regulating water discharges from A2 Installations can be found in AQ11(05) (Ref 3).

BAT

The operator should ensure that:

58. All emissions are controlled, as a minimum, to avoid a breach of water quality standards. (Calculations and/or modelling to demonstrate this may be required to be submitted to the regulator).

59. Run-off from the installation should be controlled and managed and where necessary (given the nature of the run-off) treated before discharge in a suitable effluent treatment plant.

60. All interceptors:
    - are impermeable
    - are subject to at least weekly visual inspection and, where necessary to ensure the continuous function, contamination removed
    - have an annual maintenance inspection; prior to inspection all contents should be removed

61. Process effluent is kept separate from surface drainage unless agreed with the regulator.

62. Where necessary to protect the environment, process effluent is channelled / transported to suitable effluent treatment plant.

Point source emissions to groundwater

3.184 There should be no intentional point source emissions of List I and List II substances to groundwater from the Ceramics sector[1].

BAT
63. There should be no intentional point source emissions of List I and List II substances to groundwater.

Fugitive emissions to air

3.185 Common sources of fugitive emissions are:

- Dry roadways
- Storage, handling and use of powders and dusty materials;
- Loading and unloading of transport

3.186 Internal transport of dusty materials can generate fugitive emissions. Attention to preventing fugitive emissions and, if prevention has failed, cleaning up deposits of dust on external structures and roofs will minimise wind entrainment of deposited dust.

3.187 Vehicle exhausts directed above the horizontal are preferred to prevent the exhaust raising dust.

3.188 Where necessary to prevent visible dust being carried off site, wheel-cleaning facilities should be provided and used by vehicles before leaving the site.

3.189 Spillages should preferentially be cleared by wet handling methods. Dry handling of dusty spillages should be avoided except through the use of a vacuum cleaning system.

BAT

64. Operations should be controlled with the aim of preventing visible emissions with the exception of one-off events during start-up and shut-down.

65. Where dusty materials are handled, dust should normally be controlled by covering of skips and vessels, using enclosed conveyors, spraying water on sand conveyors, minimising drops and by avoiding outdoor or uncovered stockpiles.

66. External surfaces of the process buildings, roofs, guttering, ancillary plant, roadways and open yards and storage areas should be inspected at least annually. Cleaning operations should be carried out if necessary to prevent the accumulation of dusty material using methods which minimise emissions of particulate matter to air

67. The loading and unloading of road vehicles and trains should be carried out so as to minimise dust emissions.

68. Road transport for dusty materials should be carried out in closed tankers or sheeted vehicles.

69. Transfer points of dusty materials should be enclosed and ducted to suitable arrestment equipment.

Roadways and other areas where there is regular vehicle movements should have a consolidated surface which is capable of being cleaned. These areas should be kept clean and in good repair.

[1] The Groundwater Regulations 1998 require that List I substances are prevented from entering groundwater, and that List II substances are controlled so that pollution of groundwater does not occur. Any discharge of listed substances onto or into land must be subject to a prior investigation under the terms of the Groundwater Regulations, and this investigation should be carried out by the applicant and submitted in support of the permit application.

Fugitive emissions to surface water, sewer and groundwater

3.190 The operator should have a clear diagrammatic record of the routing of all installation drainage for surface water and process effluent, to include subsurface pipework, the position of any sumps and storage vessels including the type and broad location of the receiving environment.

3.191 An inspection and maintenance programme should be established for all subsurface structures. Inspection frequencies and test methods should be chosen to prevent pollution by minimising leaks from subsurface pipework, sumps and storage vessels, having regard to the risk factors in paragraph **3.193** below.

The minimum inspection frequency should normally be no less than once every five years for yard drainage (ie rainwater from roofs, hardstanding etc) and no less than once every three years for process effluent. The precise choice of inspection frequency and the sophistication of the method should be guided by the level of risk presented but a likely maximum frequency may be once per annum.

3.192 Examples of inspection and test methods are pressure tests, leak tests, material thickness checks, and CCTV survey. Using secondary containment and/or leakage detection can serve to reduce the inspection frequency to the minimum quoted in paragraph **3.191**.

3.193 The likely risk to the environment from drainage systems is dependant on the following factors:

- nature and concentration of contaminants in the water transferred in the drainage systems
- volume of water transferred
- vulnerability of the groundwater in the locality
- proximity to surface waters.

For yard drainage, it is likely that the minimum inspection frequency and least complex inspection methods will suffice irrespective of volume of water, vulnerability of local groundwater and proximity to surface waters.

3.194 The vulnerability is defined by the nature of the subsurface, and is mapped for England and Wales in a series of Groundwater Vulnerability maps. An additional measure of risk is whether the installation sits within a Groundwater Source Protection Zone (GPZs) as defined by the Environment Agency's Groundwater Protection Policy. GPZs help to identify areas, which are particularly sensitive to groundwater pollution because of their proximity to an important water supply.

The location of GPZs can be searched on the Environment Agency website by inserting the post code of the installation http://www.environment-agency.gov.uk/maps/info/groundwater/

3.195 Operational areas comprising site transport routes (1) and mineral storage areas but excluding bulk clay storage areas should be equipped with an impervious surface, spill containment kerbs, sealed construction joints and connection to a sealed drainage system. All such areas should be identified on a site plan held at the operator's premises. The reason for these provisions is the potential leakage of transport pollutants on roadways. Management controls should be put in place, involving, in particular, regular checks on the condition of the impervious surface to ensure its integrity is maintained. These checks should identify whether there are any parts which require maintenance to prevent the seepage of polluting liquids. The results of all such inspections should be recorded in the log book together with any necessary maintenance action arising.

Storage areas for fired product ought not to need these measures.
(1) Site transport routes do not include vehicular movement areas between fired product stores as spill containment kerbing in these areas will interfere with the operation of plant.

3.196 The operator should ensure that all tanks containing liquids whose spillage could be harmful to the environment are contained. Bunds should be impermeable and resistant to the stored materials, have no outlet (drains, soakaways etc) and drain to a blind collection point. Pipework should be routed within bunded areas with no penetration of contained surfaces. Bunds should be designed to have a holding capacity of at least 110% of the largest tank and be located more than 10m from watercourses and 50m from drinking water boreholes.

It is good practice for bunds to be fitted with a high-level probe and an alarm as appropriate and are inspected regularly by the operator. Rainwater should be prevented from entering bunds, but any spills and rainwater accumulations should be removed as soon as possible.

3.197 All storage tanks should be fitted with high-level alarms or volume indicators to warn of overfilling. Where practicable the filling system should be interlocked to the alarm system of prevent overfilling. Tanks should have delivery connections located within a bunded area, fixed and locked when not in use and have their integrity inspected, recorded and documented, particularly where corrosive substances are involved. These inspections should be included in the maintenance schedule.

BAT

70. The operator should have a clear diagrammatic record of the routing of all installation drains, subsurface pipework, sumps and storage vessels including the type and broad location of the receiving environment.

71. The operator should identify the potential risk to the environment from drainage systems recorded by **BAT 71** and should devise an inspection and maintenance programme having regard to the nature and volume of waste waters, groundwater vulnerability and proximity of drainage systems to surface waters.

72. The operator should ensure that all operational areas are equipped with an impervious surface, spill containment kerbs, sealed construction joints, and connected to a sealed drainage system or such alternative requirements as approved by the regulator. The condition of the impervious surface should be checked regularly and the results of inspections and intended maintenance arising should be recorded in the log book. Operational areas do not include bulk clay storage areas or fired product storage areas.

73. It is preferable that sustainable urban drainage system techniques should be used for the drainage of open storage areas. In the event that these techniques cannot be employed then oil and grit interceptors will be required.

74. All sumps should be impermeable and resistant to stored materials.

75. All liquid storage tanks should be located within bunds that are designed, constructed and located away from watercourses and drains to appropriate standards and ensuring that the volume is more than 110% of the largest tank.

76. Storage tanks should be fitted with high-level alarms or volume indicators to warn of overfilling and where practicable the filling system should be interlocked to the alarm system to prevent overfilling. Delivery connections should located within a bunded area, fixed and locked when not in use.

77. All tanks bunds and sumps should be subject to regular visual inspection as agreed with the regulator, placed on a preventative maintenance programme. The contents of bunds and sumps should be pumped out or otherwise removed as soon as is practicable after checking for contamination.

Odour

3.198 Typically the most odorous processes involve the manufacture of whiteware and the firing of decals.

3.199 Chapter 17 of the General Guidance Manual provides guidance on controlling odour from installations and the information required in an application.

Assessment

3.200 Operators should assess the likely sources of odour and carry out olfactory assessments at the site boundary.

3.201 The overall aim should be that all emissions are free from offensive odour outside the site boundary, as perceived by the regulator. The locality will influence the assessment of the potential for odour impact for example local meteorological conditions (all predicted wind directions and weather conditions) which may lead to poor dispersion conditions. Where the site has a low odour impact due to its remoteness from sensitive receptors, the escape of offensive odour beyond the installation would be unlikely to cause harm.

BAT

78. Operators should conduct odour assessments to determine whether emissions result in offensive odours at or beyond the installation boundary.

79. If operations are identified as resulting in offensive odour, operators should devise an odour control programme of improvements and maintain an odour management plan.

Management

3.202 The following guidance on management should be read in the context of chapter 11 of the revised General Guidance Manual on operator competence (to be published in 2008).

3.203 Within IPPC, an effective system of management is a key technique for ensuring that all appropriate pollution prevention and control techniques are delivered reliably and on an integrated basis.

3.204 An effective Environmental Management System (EMS) will help the operator to maintain compliance with regulatory requirements and to manage other significant environmental impacts. An EMS includes an environmental policy and programme which:

- includes a commitment to continual improvement and prevention of pollution;
- includes a commitment to comply with relevant legislation and other requirements to which the organisation subscribes; and
- identifies, sets, monitors and reviews environmental objectives and key performance indicators independently of the Permit.

3.205 The operator should have demonstrable procedures (e.g. written instructions) which incorporate environmental considerations into process control, design, construction and review of new facilities and other capital projects (including provision for their decommissioning), capital approval and purchasing policy.

Audits should be carried out, at least annually, to check that all activities are being carried out in conformity with the above requirements. Reporting should be carried out annually on environmental performance, objectives and targets, and future planned improvements. Ideally, these should be published environmental statements.

Operations and maintenance

3.206 **Maintenance** - It is good practice to ensure:

- effective preventative maintenance on all aspects of the process the failure of which could impact on the environment

- clear written maintenance instructions for all relevant items are developed and maintained
- a method of reviewing maintenance needs, with demonstrable evidence that this process takes place

3.207 **Training** – all relevant (including operational) staff should be trained in the regulatory implications of the permit, all potential environmental impacts (under normal and abnormal circumstances). Training should also include the procedures for dealing with a breach of the permit conditions, prevention of accidental emissions and action to be taken when accidental emissions occur and also in all operating procedures.

3.208 **Responding to problems** - The regulator needs to be notified about certain events and expects the operator to respond to problems, which may have an effect on emissions to the environment. Such problems may arise within the process itself or, for example, with the abatement

3.209 **Contractors on site** - It is important to be aware that in complying with their permit, operators will be responsible for work undertaken by contractors. Operators are advised to provide instructions to contractors regarding protecting the environment whilst working on site.

BAT

Environmental Management System

80. Operators should use an effective Environmental Management System with policies and procedures for environmental compliance and improvements. Audits should be carried out against those procedures at regular intervals.

Operations and maintenance

81. Effective operational and maintenance systems should be employed on all aspects of the installation whose failure could impact on the environment. As a minimum this should cover all abatement equipment. Such systems should be reviewed and updated annually.

82. Environmentally critical process and abatement equipment (whose failure could impact on the environment) should be identified and listed. The regulator should be provided with a list of such equipment.

83. For equipment referred to in BAT 83 (above):
    - Alarms or other warning systems should be provided, which indicate equipment malfunction or breakdown.
    - Such warning systems should be maintained and checked to ensure continued correct operation, in accordance with the manufacturer's recommendations
    - Essential spares and consumables for such equipment should be held on site or be available at short notice from suppliers, so that plant breakdown can be rectified rapidly.

84. Records of breakdowns should be kept and analysed by the operator in order to eliminate common failure modes.

Competence and training

85. A competent person should be appointed to liaise with the regulator and the public with regard to complaints. The regulator should be informed of the designated individual(s).

86. A formal structure shall be provided to clarify the extent of each level of employee's responsibility with regard to the control of the process and its environmental impacts. This structure shall be prominently displayed on the company within the process building at all times. Alternatively, there must be a prominent notice referring all relevant employees to where the information can be found.

87. Personnel at all levels shall be given training and instruction sufficient to fulfil their designated duties under the above structure. Details of such training and instruction shall be entered into the employees record and be made available for inspection by the regulator.

88. The potential environmental risks posed by the work of contractors should be assessed and instructions provided to contractors about protecting the environment while working on site.

Accidents/incidents/non conformance

89. There should be written procedures for investigating incidents, (and near misses) which may affect the environment, including identifying suitable corrective action and following up.

Raw Materials

3.210 This section covers the use of raw materials and water and the techniques for optimising their use and minimising their impact by selection (Energy and fuels are covered under **Energy**).

3.211 As a general principal, the operator will need to demonstrate the measures taken to:

- **reduce** the use of chemicals and other materials (**Waste minimisation (optimising the use of raw materials)**)
- **substitute** with materials presenting lower risks to the environment
- **understand** the fate of by-products and contaminants and their environmental impact

Raw materials selection

3.212 Raw materials used in the ceramics sector may include:

- Clay
- Minerals
- Fuel
- Water

3.213 The criteria in **Table 7** should be considered when selecting raw materials

Table 7: Selection of raw materials

Raw material	Selection criteria
Clay	Suitability for product, level of pollution emitted. Clays, which vary widely in fluoride and, sulphur content which are potential pollutants and calcite content (and other sources of calcium oxide during firing which tend to capture sulphur and fluoride emissions). The concentration of fluoride emissions is not directly dependant on the concentration of fluoride in the clay.
Pore forming agents	Suitability for product, effect on level of pollution emitted
Mineral additives e.g. lime stone for ceramic tiles	Suitability for product, effect on level of pollution emitted
Additives to enhance product aesthetics	Suitability for product, effect on level of pollution emitted
Fluxes and binders	Suitability for product, effect on level of pollution emitted
Magnesia, alumina and chrome minerals	Suitability for product, effect on level of pollution emitted
Metal additions	Suitability for product, effect on level of pollution emitted
Direct printing inks	Suitability for product, effect on level of pollution emitted

Raw and prefritted glaze	Suitability for product, effect on level of pollution emitted
Water	Identify most sustainable source (consider recycled sources)
Scrap	Impurities and contamination of scrap may affect emissions to all media.
Fuel oils	Sulphur content should be minimised. The maximum sulphur content of heavy fuel oil should be 1%.
Machine oils/emulsions	Minimise organic content of emulsions Consider synthetic oils
*Sulphur in liquid fuels regulations, Regulation 3 (3) states that combustion plant (other than new large combustion plant covered by the LCPD for which there is a separate provision) can burn heavy fuel oil with a sulphur content greater than 1% so long as the sulphur dioxide emissions from the plant is less than or equal to 1700mg/m3 at 3% oxygen dry. Defra is the enforcing authority for these regulations.	

3.214 When selecting alternative raw materials, operators should ensure that decisions are taken on the basis of their environmental impact, whilst not compromising casting quality and product integrity.

BAT
90. The operator should adopt procedures to control the specification of those types of raw materials with the main potential for environmental impact, in order to minimise any potential environmental impact. An annual review of alternative raw materials should be carried out with regard to environmental impact.

Waste minimisation (optimising the use of raw materials)

3.215 Waste minimisation can be defined simply as: *"a systematic approach to the reduction of waste at source, by understanding and changing processes and activities to prevent and reduce waste".*

3.216 A variety of techniques can be classified under the term waste minimisation and they range from basic housekeeping techniques through statistical measurement techniques, to the application of clean technologies.

3.217 Key operational features of waste minimisation should be:

- the ongoing identification and implementation of waste prevention opportunities
- the active participation and commitment of staff at all levels including, for example, staff suggestion schemes
- monitoring of materials' usage and reporting against key performance measures or benchmarks

3.218 Using this information, opportunities for waste reduction, changes in process and improved efficiency should be generated and assessed, and an action plan prepared for the implementation of improvements.

3.219 A list should be kept of all the different raw material used in the process, including clay, sand, and wrapping plastic (but not fuel which is addressed by the energy section of this note), and the quantity used in each year. The purpose of this is to monitor changes in the amount of raw materials used against the amount of product produced, so as to be able to compare year-on-year efficiencies and have the basis for considering the scope for reducing the amount of raw material inputs.

3.220 There should be continuous movement towards more Sustainable Consumption and Production (i.e. doing more for less) as laid out in Government Guidance " Changing Patterns - UK Government Framework for Sustainable Consumption and Production" (**Ref 7**). Section 3.3 of the guidance identifies advice and funding programmes available to achieve more sustainable production practices. The National Industrial Symbiosis Programme shares information across all industrial sectors to produce guidance and case studies for resource efficiency (**Ref 7**). See also Envirowise Guides (**Ref 7**) for information.

BAT
91. The operator should record materials usage and waste generation in order to establish internal benchmarks. Assessments should be made against internal benchmarks to maintain and improve resource efficiency. 92. The operator should carry out a waste minimisation audit at least as frequently as the permit review period. If an audit has not been carried out in the 2 years prior to submission of the application it should be completed within 18 months of the issue of the first PPC permit. The methodology used and an action plan for optimising the use of raw materials should be submitted to the regulator within 2 months of completion of the audit. 93. Specific improvements resulting from the recommendations of audits should be carried out within a timescale approved by the regulator.

Water use

3.221 Water use should be minimised within the BAT criteria for the prevention or reduction of emissions and be commensurate with the prudent use of water as a natural resource.

3.222 Reducing water use may be a valid environmental and/or economic aim in itself, perhaps because of local supply constraints. Also, from the point of view of reducing polluting emissions, any water passing through an industrial process is degraded by the addition of pollutants, and there are distinct benefits to be gained from reducing the water used. These include:

- reducing the size of (a new) treatment plant, thereby supporting the cost benefit BAT justification of better treatment
- cost savings where water is purchased or disposed of to another party
- associated benefits within the process such as reduced energy requirements for heating and pumping, and reduced dissolution of pollutants into the water leading to reduced sludge generation in the effluent treatment plant

The use of a simple mass balance for water use may help to reveal where reductions can be made.

3.223 The following general principals should be applied in sequence to reduce emissions to water:

- water-efficient techniques should be used where possible
- water should be recycled within the process from which it issues, treating it first if necessary. Where this is not practicable, it should be recycled to another part of the process which has a lower water quality requirement

3.224 The volumes of water used by an installation should normally be metered so that water efficiency audits can be carried out and benchmarks can be set for optimal efficiency. In addition, sub-processes that are principal water users should be metered to optimise water usage at individual process plant

BAT
94. The operator should carry out a regular review of water use (water efficiency audit) at least as frequently as the permit review period. If an audit has not been carried out in the 2 years prior to submission of the application it should be completed within 18 months of the issue of the first PPC

permit.
95. Using information from the water efficiency audit, opportunities for reduction in water use should be assessed and, where appropriate, should be carried out in accordance with a timescale approved by the regulator.

Waste handling

3.225 Good segregation of materials is essential to facilitate opportunities for recovery, recycling and re-use and to maximise scope for good waste management.

3.226 The most important wastes are:

- Off spec product
- Scrubber waste
- Particulate from air abatement filters
- Glaze
- Plaster of paris moulds
- General inert industrial waste including small quantities of waste oil.

BAT

96. The operator should produce an inventory of the quantity, nature, origin and where relevant, the destination, frequency of collection, mode of transport and treatment method of any waste which is disposed of or recovered.

97. Operators should segregate the main waste types described in paragraph **3.226**.

98. Operators should ensure that waste stored in containers that are durable for the substances stored and that incompatible waste types are kept separate.

99. Operators should ensure that waste storage areas are clearly marked and signed, and that containers are clearly labelled.

Waste re-use, recovery, recycling or disposal

3.227 Waste should be re-used, recovered or recycled unless the regulator has accepted a satisfactory BAT justification for landfill disposal.

3.228 **Table 8** summarises the routes currently taken by the various waste streams from a typical Ceramic site. Whether re-use, recovery or recycling is possible at a particular site will depend on the particular fuels and raw materials being used, the products being made and the methods of operation employed. The table reflects where recycling can be achieved when the appropriate combination of these factors is in place.

3.229 In the context of this note, recycling means the residue is returned to the process from where it has been produced, re-use means that the residue is used for another purpose e.g fired brick used in quarry roadways

3.230 Operators should seek to establish markets for the recovery or recycling of wastes generated within the installation. Envirowise guides provide information on recycling. In addition, the Waste & Resources Action Programme (WRAP) researches and can provide guidance into recycling of wastes such as wood, paper, cardboard and plastics (**Ref 9**).

Table 8: Solid waste stream: routes currently taken

Process waste stream	Fate
Unfired waste	Re-use
Fired waste	Re-use, Recycle, Recover, crushed for Quarry roadways.
collected dusts	Re-use
Steel bands from pallet packaging	Re-used or off-site recycling
Waste water treatment sludge	Re-use, off-site recovery/recycling or disposal
Scrubber liquors and sludges	Minimised, then to licensed waste disposal contractors
Wood, cardboard and paper	Segregated for off site re-use or recovery
Oil	Recovery off site

BAT

100. The operator should carry out an annual review to demonstrate that the best environmental options are being used for dealing with the waste streams listed on **Table 8**.

101. At a minimum of every two years, the operator should investigate potential markets for the recovery/re-use of wastes that are currently disposed of to landfill.

Energy

3.231 BAT for energy efficiency under the PPC Regulations will be satisfied provided the operator meets the following conditions:

either
• the operator meets the basic energy efficiency requirements below and is a participant to a Climate Change Agreement (CCA) with the Government or EUETS commitments

or
• the operator meets the basic energy efficiency requirements below and the additional energy efficiency requirements

Basic energy efficiency requirements

3.232 The requirements of this section are basic, low cost, energy standards that apply whether or not a CCA, is in force or the operator has EUETS commitments for the installation.

BAT

102. The operator should produce a report annually on the energy consumption of the installation.

103. The operator should monitor energy flows and target areas for reduction which should be updated annually. ("Sankey" diagrams and energy balances would be useful as aids.)

104. Optimisation of combustion will improve fuel efficiency. Monitoring oxygen in waste gases will enable

the operator to ensure that the process of combustion is optimised.

105. The operator should ensure that all plant is operated and maintained to optimise the use and minimise the loss of energy.

106. The operator should ensure that all appropriate containment methods, (e.g. seals and self-closing doors) are employed and maintained to minimise energy loss.

Additional energy efficiency requirements

3.233 The following techniques result in improved energy efficiency:

- use of recuperative burners, heat exchangers and boilers to recover heat from process gases
- use of oxygen enriched air or oxygen in burners reduces energy consumption. Waste gas volumes are also significantly reduced allowing smaller fans, ducting and abatement plant to be used for example

3.234 Within IPPC it is valid to consider both the emission of direct (heat and emissions from on-site generation) and indirect (emissions from a remote power station) pollution when considering options for energy efficiency.

BAT

Energy efficiency techniques

107. The following techniques should be considered:

- heat recovery from different parts of the processes
- minimisation of water use and closed circulating water systems
- good insulation
- plant layout to reduce pumping distances
- phase optimisation of electronic control motors and fans
- preventative maintenance programme targeting energy drops
- Use of heat exchanger
- Oxygen enhanced fuel usage

Energy supply techniques

108. The following techniques should be considered:

- use of Combined Heat and Power (CHP)
- use of less polluting fuels

Accidents

3.234 The following guidance on accidents management should be read in the context of chapter 20 of the revised General Guidance Manual on accidents (to be published in 2008).

3.235 For accident management, there are three particular components:

- **identification of the hazards** to the environment posed by the installation/activity
- **assessment of the risks** (hazard x probability) of accidents and their possible consequences
- implementation of **measures to reduce the risks** of accidents, and contingency plans for any accidents that occur

3.236 Chapter 20 of the General Guidance Manual provides guidance that may be relevant in the event of fire. See also **Ref 10** and **Ref 11**.

Identification of the hazards

3.237 In identifying the hazards particular areas to consider may include, but should not be limited to, the following:

- Transfer of materials
- Plant or equipment failure (pump or fan failure, blocked drain)
- Fire
- Vandalism
- Vehicle movements

Identification of the risks

3.238 The hazards having been identified, the process of assessing the risks should address the following:

- how likely is the particular event to occur (source frequency)?
- what substances are released and how much of each (risk evaluation of the event)?
- where do the released substances end up (emission prediction - what are the pathways and receptors)?
- what are the consequences (consequence assessment – what are the effects on the receptors)?
- what is the overall risk (determination of overall risk and its significance to the environment)?
- what can prevent or reduce the risk (risk management – measures to prevent accidents and/or reduce their environmental consequences)?

Measures to reduce the risks (identified by risk assessment)

3.239 Risk reduction can be achieved by process management controls and preventative measures. The following techniques will be relevant to most installations, although this is not an exhaustive list.

Process management controls

- process design, alarms, trips and other failsafe control techniques to ensure the safe operation of the plant
- security systems to prevent unauthorised access
- records of all incidents, near-misses, changes to procedures, abnormal events and findings of maintenance inspections and procedures to learn from such incidents
- personnel suitably trained in accident management
- guidance for specific accident scenarios
- procedures to ensure good communication among operations staff during shift changes and maintenance or other engineering work
- safe shutdown procedures
- established communication routes with relevant authorities and emergency services

Preventative measures

- procedures to ensure that the composition of the contents of a bund /sump is checked before treatment or disposal
- drainage sumps equipped with a high-level alarm with automatic pump to storage (not to discharge)
- high-level alarms etc. (which should not be routinely used as the primary method of level control)
- adequate standby plant or equipment maintained and tested to operational standards
- sufficient storage to contain process waters, site drainage waters, emergency firewater, chemically contaminated waters and spillages of chemicals, which should be routed where necessary, having regard to a site-specific assessment of risks, to the effluent system
- provision to contain surges and storm-water flows, which should be treated where necessary, having regard to a site-specific assessment of risks, before emission to controlled waters or sewer
- spill contingency procedures to minimise the risk of accidental emission of raw materials, products and waste materials and to prevent their entry into water
- procedures should be in place for checking and handling raw materials and wastes to ensure compatibility with other substances with which they may accidentally come into contact.
- suitable barriers to prevent damage to equipment from the movement of vehicles, as appropriate, having regard to a site-specific assessment of risks
- there should be procedures for responding to and learning from incidents, near-misses, etc.
- the roles and responsibilities of personnel involved in incident management should be formally specified.

- where indicated by the site-specific assessment of risks, containment or abatement for accidental emissions from vents and safety relief valves/bursting discs should be provided. Where this may be inadvisable on safety grounds, attention should be focused on reducing the probability of the emission

BAT
Accidents/incidents/non conformance 109. There should be written procedures for investigating incidents and near misses, including identifying suitable corrective action and following up. 110. The operator should maintain an accident management plan covering the matters listed in paragraphs **3.237** to **3.239** above and to the satisfaction of the regulator. The plan should be available for inspection by the regulator. 111. In the case of abnormal emissions arising from an accident, such as a spillage for example, the operator should: • Investigate undertake remedial action immediately • promptly record the events and actions taken • ensure the regulator is made aware without delay **Specific conditions** 112. Specific conditions may need to be included within permits to prevent accidents. Examples of these are given below. 113. Operators should provide for safe storage and conveying systems for both liquid raw materials and wastes in order to minimise the potential for vandalism or accidental damage. Regular inspection should be carried out on pipelines, valves and pumps to inspect for damage and wear. 114. The operator should maintain procedures for the control of spills and of firewater to ensure containment and disposal of liquids in order to prevent or minimise pollution. 115. Systems should be used to avoid excessive transfer rates of solids by pneumatic conveyors that might lead to over pressurisation and filter failure or tank / silo overfilling leading to spillage of liquids or powders. 116. Operators should ensure that materials are charged into the correct silo or tank to minimise the potential for causing waste, spillage or uncontrolled chemical reaction. 117. Operators should use safe systems of for the handling and storage of dust in order to minimise the risk of fire and explosion. 118. Operators should design delivery routes to minimise accidental damage by vehicles to any storage facilities for liquids or dusts. Where a risk of vehicular damage to such storage areas has been identified, crash barriers should be fitted.

Noise and Vibration

3.240 Within this section, “noise” should be taken to refer to noise and/or vibration as appropriate, detectable beyond the site boundary.

3.241 The most significant source of noise arises as a result of the following activities:
- Transport
- Tumbling machines for ‘ageing’ bricks

3.242 Noise surveys, measurement, investigation (which can involve detailed assessment of sound power levels for individual items of plant) or modelling may be necessary for either new or existing installations depending upon the potential for generating significant noise. Operators may have a noise management plan as part of their management system. Where an installation poses no risk of noise related environmental impact because the activities undertaken are inherently quiet or remote from receptors; these measures would not normally be required.

3.243 Following investigation of the impact of the installation, systems to minimise the environmental impact of the noisiest operations should be employed. The level of noise control required depends on the scale of operations and the proximity of operations to the public. **Table 9** identifies the noisiest operations and the control measures the have been employed to mitigate problems

3.244 Further guidance can be found in chapter 16 of the General Guidance Manual.

Table 9: Noise Mitigation Measures

Operation	Control Measure
Brick Tumbling	▪ Acoustic screens and enclosures ▪ Preventative maintenance programme e.g. equipment wear, bearings
Scrap Handling and charging	▪ Develop storage systems to avoid double handing ▪ Minimising charging height ▪ Use screens and barriers to conceal noise sources
Site Vehicle Movements	▪ Using vehicles with "directional and localised sound" for reverse alarms to concentrate noise at the area of immediate danger ▪ Replacing diesel powered forklift trucks with electric or LPG powered ▪ Minimising vehicle movements at night ▪ Using even roadways for vehicle movements
Fans, pumps and motors	▪ Acoustic screens, enclosures and baffles ▪ Fitting silencers to avoid noise travelling along ducting ▪ Selection of less noisy engineering equipment ▪ Fitting resilient hangers for wall-mounted equipment
General	▪ Fitting noise reducing flaps to outside doors ▪ Maintaining a closed doors policy ▪ Improving sound insulation of buildings ▪ Holes and openings closed off (use mechanical where necessary) ▪ Fitting anti-vibration mounts on plant ▪ Using flexible connections between vibrating and fixed plant ▪ Preventative maintenance programme e.g. equipment wear, bearings
* Noise mitigation measures that are likely to be needed in most cases [sector specific assessment of the noise mitigation measures relevant]	

BAT

119. The operator should identify key plant and equipment (or operations) with the potential to give rise to significant noise and take such measures as are necessary by way of mitigation and maintenance of existing plant and equipment in order to minimise noise having regard to paragraph **3.243** and **Table 9** above.

Monitoring

3.245 This section describes general monitoring and reporting requirements for emissions to all environmental media. Guidance is provided for the selection of the appropriate monitoring methodologies, frequency of monitoring, compliance assessment criteria and environmental monitoring.

Standards for monitoring equipment and procedures

3.246 The Environment Agency has introduced its Monitoring Certification Scheme (MCERTS) to improve the quality of monitoring data and to ensure that the instrumentation and methodologies employed for monitoring are fit for purpose.

- operators should ensure their monitoring arrangements comply with the requirements of MCERTS where available, e.g. using certified instruments and equipment, and using a registered stack testing organisation etc.

See **http://www.environment-agency.gov.uk** for listing of MCERTS equipment.

Sampling and analysis standards

3.247 The sampling analytical methods selected for compliance monitoring given in Technical Guidance Note M2 (**Ref 12**) should normally be used in the following order of priority:

- Comité Européen de Normalisation (CEN)
- International Standardisation Organisation (ISO)
- British Standards Institution (BSI)
- United States Environmental Protection Agency (US EPA)
- American Society for Testing and Materials (ASTM)
- Deutsches Institut für Normung (DIN)
- Verein Deutcher Ingenieure (VDI)
- Association Française de Normalisation (AFNOR)

3.248 Guidance on standards for monitoring releases (to air, water and land) relevant to IPPC can be found in **Ref 12**.

3.249 When selecting monitoring test methods, it is important to note that test methods are normally applicable to specific matrices (in relation to water) and concentrations of various pollutants (in relation to air). It is necessary to identify the most appropriate method in consideration of the hierarchy of methods. For example, if two methods are appropriate, the hierarchy is used to determine priority.

3.250 If in doubt the operator should consult the regulator.

Monitoring and sampling protocols

3.251 Where monitoring is needed the operator should devise a monitoring strategy to address the following:

- determinands to be monitored
- selection of monitoring points
- monitoring methods and procedures (selection of appropriate Standard Reference Methods)
- reference conditions and averaging periods
- measurement uncertainty of the proposed methods and the resultant overall uncertainty
- drift correction for continuous analysers
- quality assurance (QA) and quality control (QC) protocols, including accreditation and certification
- equipment calibration and maintenance, sample storage and chain of custody/audit trail
- reporting procedures, data storage, interpretation and review of results, reporting format for the provision of information to the regulator

Monitoring frequency

3.252 The frequency of testing should be increased, for example, as part of the commissioning of new or substantially changed activities, or where the emission levels are near to or approach the emission limit.

3.253 Where non-continuous quantitative monitoring is required, the frequency may be varied. Where there is consistent compliance with emission limits, regulators may consider reducing the frequency. When determining 'consistent compliance' factors to consider include:

- the variability of monitoring results, for example, results which range from 15 - 45 mg/m^3 , against an emission limit of 50 mg/m^3 might not qualify for a reduction in monitoring

- the margin between the results and the emission limit, for example, results which range from 45 - 50 mg/m^3 when the limit is mg/m^3 might not qualify for a reduction in monitoring

3.254 Consistent compliance should be demonstrated using sequential results for example at least three or more monitoring exercises within two years, or two or more monitoring exercises in one year supported by continuous monitoring. Any significant process changes which might have affected the results should be taken into account.

3.255 Where effective surrogates are available they may be used to minimise monitoring costs.

3.256 Where monitoring shows that substances are not emitted in significant quantities, consideration can be given to a reduced monitoring frequency.

Monitoring emissions to air

3.257 The reference conditions of substances in releases to air from point sources are: for kiln emissions temperature 273.15 K (0°C), pressure 101.3 kPa (1 atmosphere) 18% oxygen measured dry, and averaged over the firing cycle of the kiln. For other emissions temperature 273.15 K (0°C), pressure 101.3 kPa (1 atmosphere) without correction for water vapour content. To convert measured values to reference conditions, see Technical Guidance Note M2 (**Ref 12**) for more information.

Monitoring emissions to water

3.258 The appropriateness of the monitoring requirements in Section 2 will vary depending upon the sensitivity of the receiving water and should be proportionate to the scale of the operations, nature of the discharge and receiving water. For each release point the following information is required:

- the specific volume flow from the process to sewer/controlled water
- the quality of the receiving water
- the volume of discharge compared to the percentage dry river flow of the receiving water

Environmental monitoring (beyond installation)

3.259 Environmental monitoring may be required, for example, when:

- there are vulnerable receptors
- the emissions are a significant contributor to an Environmental Quality Standard (EQS) which may be at risk
- the operator is looking for departures from standards based on lack of effect on the environment
- the operator is required to validate modelling work

3.260 Further guidance is given in chapter 15 of the General Guidance Manual.

Monitoring of process variables

3.261 Some process variables will have potential environmental impact and these should be identified and monitored where they have an environmental relevance. For ceramic activities, examples of monitoring these variables include:[given as examples only]

- keeping inventories of materials used and disposed of
- monitoring temperature or pressure where relevant, for example pressure drop across bag filters
- plant efficiency monitoring, for example brick forming plant efficiency

BAT

Monitoring and reporting

120. The operator should monitor emissions, make tests and inspections of the process and keep records; in particular the operator should keep records of audits, inspections, tests and monitoring, including all non-continuous monitoring, inspections and visual assessments. Monitoring may include process variables and operating conditions where relevant to emissions. In such cases:

- current records should be kept on site and be made available for the regulator to examine
- records should be kept by the operator for at least two years

121. The operator should notify the regulator at least 7 days before any periodic monitoring exercise to determine compliance with emission limit values. The operator should state the provisional time and date of monitoring, pollutants to be tested and the methods to be used

122. The results of non-continuous emission testing should be forwarded to the regulator within 8 weeks of the completion of the sampling. Results from continuous monitoring systems should be recorded and be made available for inspection by the regulator.

123. All results submitted to the regulator should include details of process conditions at the time of monitoring, monitoring uncertainty as well as any deviations from the procedural requirements of standard reference methods and the error invoked from such deviations.

124. Results exceeding the emission limit value from **any** monitoring activity (both continuous and non-continuous) and malfunction or breakdown leading to abnormal emissions should be investigated and corrective action taken immediately. The operator should ensure that the regulator is notified without delay identifying the cause and corrective action taken. Where there is immediate danger to human health, operation of the activity should be suspended.

125. Sampling points on new plant should be designed to comply with CEN or Other Standards. e.g. BS EN 13284-1 or BS ISO 9096: 2003 for sampling particulate matter in stacks.

126. Where continuous monitoring is required by the permit, instruments should be fitted with audible and visual alarms, situated appropriately to warn the operator of arrestment plant failure or malfunction, the activation of alarms should be automatically recorded and readings should be on display to appropriately trained operating staff.

127. All continuous monitors should be operated, maintained and calibrated (or referenced) in accordance with the appropriate standards and manufacturers' instructions, which should be made available for inspection by the regulator. Instruments should be operated to ensure less than 5% downtime over any 3-month period and all relevant maintenance and calibration (or referencing) should be recorded

128. Where available, operators should use monitoring equipment and instruments certified to MCERTS and use a stack-testing organisation accredited to MCERTS standards or such alternative requirements as approved by the regulator.

Monitoring and reporting of emissions to air

129. Exhaust flow rates of waste gases should be consistent with the efficient capture of emissions, good operating practice and meeting the requirements of the legislation relating to the workplace environment.

130. The introduction of dilution air to achieve emission concentration limits should not be permitted.

131. Dilution air may be added where justified for waste gas cooling or improved dispersion. In such cases, monitoring should be carried out upstream of the dilution air input or procedures designed to correct for the ratio of input air to the satisfaction of the regulator.

132. Monitoring to determine compliance with emission limit values should be corrected to the following standard reference conditions: for kiln emissions, temperature 273.15 K (0°C), pressure 101.3 kPa (1 atmosphere) 18% oxygen measured dry, and averaged over the firing cycle of the kiln. For other emissions temperature 273.15 K (0°C), pressure 101.3 kPa (1 atmosphere) without correction for water vapour content

133. Periodic visual assessment of releases should be undertaken as required by the regulator to ensure that all final releases are colourless, free from persistent visible emissions and free from droplets.

134. Frequency of monitoring for all pollutants (including particulate matter) where arrestment equipment is necessary to meet specified emission limits should be at least annually.

135. For arrestment plant that does not serve kilns or silos
    - Continuous monitoring requirements should not be applied where emissions do not exceed 50mg/m^3 without the use of any arrestment plant. This should be demonstrated by a single

isokinetic sampling exercise undertaken in accordance with paragraph 3.258. A further such monitoring exercise may be required in the event of a substantial change to the process.

- Where wet arrestment plant is used, the liquor circulation should be monitored by suitable instrumentation such as a variable orifice meter, to provide continuous indication of liquor flow.
- Where particulate matter emissions are abated using a wet scrubber, the scrubber should be regularly inspected and maintained. Action should be taken to deal with any blockages that occur due to accumulation of solids, for example adding flocculating agents to the liquor to settle the solids out.
- Where a bypass of arrestment plant is installed for safety reasons, the bypass should be kept closed during normal operation. The regulator should be advised of the frequency of opening for safety checks. Every opening of the bypass should be automatically recorded and all reasons for, and the duration of, opening of the bypass should be recorded.

Monitoring and reporting emissions to water and sewer

136. The appropriateness of the monitoring requirements will vary depending upon the sensitivity of the receiving water and should be proportionate to the scale of the operations, nature of the discharge and receiving water. For each release point the following information is required:
    - the specific volume flow from the process to sewer/controlled water
    - the sensitivity of the receiving water
    - the volume of discharge compared to the percentage dry river flow of the receiving water

137. Increased monitoring should be carried out where substances to which the local environment may be susceptible could be released from the installation, e.g. where releases of common pesticides or heavy metals may occur.

138. A full analysis, to include the substances listed in Schedule 5 of the Regulations, should be carried out annually on a representative sample from each release point, unless it is agreed with the regulator that this is inappropriate.

Monitoring and reporting of waste

139. The following should be monitored and recorded for all waste which is consigned off-site:
    - Quantity nature and origin of the waste
    - the physical description of the waste
    - a description of the composition of the waste
    - any relevant hazardous properties (hazard and risk phrases)
    - European Waste Catalogue code
    - Handling precautions and substances with which it cannot be mixed
    - Disposal routes for each waste category

Information Provisions

3.262 This guidance note contains many provisions relating to information. There are two general categories of information identified in this note:
- Reports or notifications
- Additional information

3.263 Reports are required and notifications are information that should be sent to the regulator at a frequency that is specified in this guidance. Such information provisions are summarised in **Table 10a** below.

Table 10a: Summary of Provisions for Reporting and Notification

BAT Clause	Provision	Information Category	Frequency
BAT 52	Investigation of the cause and nature of any persistent any visible emissions	Report	Reactive
BAT 83	List of key process equipment and process and abatement	Report	Within 12 months

	equipment whose failure could impact on the environment		of publication of this note
BAT 121 & 123	Report of results from non-continuous emission testing forwarded to the regulator.	Report	Within 8 weeks of the completion of the sampling – typically annual
BAT 86	Notification of appointed competent person to liaise with the regulator and the public with regard to complaints	Notification	Reactive
BAT 112	Investigation of abnormal emissions arising from an accident. Remedial action taken immediately. Prompt recording of the events and actions taken. Notification of the regulator without delay*	Notification	Reactive
BAT 122	Notification at least 7 days before any periodic monitoring exercise to determine compliance with ELVs	Notification	Reactive
BAT 125	Investigation of results exceeding an ELV from any monitoring activity and malfunction or breakdown leading to abnormal emissions. Corrective action taken immediately. Notification without delay* identifying the cause and corrective action taken.	Notification	Reactive
*Without delay In most cases it should be enough to notify the local authority (by telephone or facsimile) within an hour of the start or detection of the emission. Local authorities will wish to consider what notification arrangements to require outside working hours.			

3.264 Additional information relates to procedures or records (including details of assessments, investigations and audits). Such information should be held by the operator and be accessible so that the regulator may view the information. For much of the information, on-site inspection may be sufficient for the regulator, subject to the particular circumstances. Regulators may be more likely to ask operators to send them copies of those items marked with an asterisk. The majority of this information is likely to be the same as would be required in any event when using an effective EMS, so documents can be produced which serve both purposes.

3.265 Annex 4 of ISO 14001 gives some detailed examples of information and document control but by way of generality A.4.4 states that "The extent of the environmental management system documentation may differ from one organization to anther depending on
(a) the size and type of organization and its activities, products of services,
(b) the complexity of processes and their interactions, and
(c) the competence of personnel

Examples of documents include
- statements of policy, objectives and targets,
- information on significant environmental impacts,
- procedures,
- process information,
- organisational charts,
- internal and external standards,
- site emergency plans, and
- records"

3.266 Relating to documentation, Annex I of the EC Regulation No 761/2001 on the eco-management and audit scheme (EMAS) states that "the organisation shall establish and maintain procedures for controlling all documents required by this International Standard…". The Annex goes on to provide details on what is required and includes the following headings:
- Structure and responsibility
- Training, awareness and competence
- Management review
- Communication
- Environmental management system documentation
- Document control
- Operational control
- Emergency preparedness and response
- Monitoring and measurement
- Non-conformance and corrective and preventive action
- Records

- Environmental management system audit

3.267 Additional information provisions are summarised in **Table 10b** below.

Table 10b: Summary of Provisions for Additional Information

BAT Clause	Category	Subject
BAT 72	Procedures	Leak prevention from subsurface structures (control, maintenance and inspection).
BAT 78	Procedures	Preventative maintenance programme for tanks bunds and sumps
BAT 81	Procedures	Environmental Management System. Records of EMS audits
BAT 82	Procedures	Operational and maintenance systems for all aspects of the installation whose failure could impact on the environment – annual review
BAT 87 & 88	Procedures	Formal structure of employee's responsibility for process control and environmental impacts and training provisions
BAT 90	Procedures	Investigating accidents, incidents and non-conformance
BAT 91	Procedures	Control the specification of raw materials with respect to their environmental impact. Review of alternative raw materials
BAT 110	Procedures	Incidents and near misses investigation. Corrective action and following up
BAT 115	Procedures	Spills and firewater control to ensure containment and disposal of liquids
BAT 116	Procedures	Systems to avoid excessive transfer rates of solids
BAT 118	Procedures	Safe systems for the handling and storage of product dust
BAT 60	Records	Inspections and maintenance of interceptors
BAT 71	Records	Subsurface structure mapping
BAT 78	Records	Visual inspection of tanks, bunds and sumps
BAT 79	Records	Odour assessments
BAT 91 & 95	Records	Raw material and water usage benchmarks
BAT 93 & 94	Records	Waste minimisation audits and improvement programme
BAT 95 & 96	Records	Water efficiency audit and water efficiency improvement programme
BAT 97	Records	Waste inventory and treatment method
BAT 101	Records	Annual review of waste disposal and recovery options
BAT 103	Records	Annual energy audit
BAT 111	Records	Accident management plan
BAT 120	Records	Identification of key plant and equipment with the potential to give rise to significant noise. Mitigation measures
BAT 121	Records	Results from continuous monitoring systems
BAT 128	Records	Maintenance and calibration of continuous monitoring systems
BAT 139	Records	Analysis for Schedule 5 substances (where needed)
BAT 140	Records	Records of waste monitoring and recording

3.268 The amount of information and size of reports or documents required under the information provisions should be decided on a 'fit for purpose' basis. The label 'report' or 'record' should not be taken to imply that a sizeable document must be submitted if the required information can be provided in much shorter form. A report could comprise a paragraph or two if that was agreed to be sufficient for the purpose. Alternatively, lengthy documents may be necessary in particular circumstances.

All the information listed in Tables 10a and b is considered necessary either

a) for regulators to keep a watch on the performance of an installation (e.g. monitoring data and who is the competent person to liaise with over complaints) or on the operator's efforts to improve performance (e.g. waste minimisation and energy audits), and/or

b) for operators to maintain an appropriate level of control over the installation, and which regulators should have access to should they wish to check that the information is being properly kept or to examine the information for regulatory purposes.

References

Environment Agency documents referred to below are available from the Environment Agency website **http://www.environment-agency.gov.uk**. Many of the references below are being made available free of charge for viewing or download on the website. The same information can also be accessed via the SEPA website **http://www.sepa.org.uk**, or the NIEHS website **www.ehsni.gov.uk**

Ref 1 *The Pollution Prevention and Control (England and Wales) Regulations (SI 1973 2000) as amended* (**www.legislation.hmso.gov.uk**) or the Scottish equivalent SSI 323 2000

Ref 2 *Secretary of State's Guidance (England and Wales): General Guidance Manual on Policy and Procedures for A2 and B Installations , March 2003* - available from the Defra website and, in hard copy, from the Defra Publications line 08459 556000 **www.defra.gov.uk/environment/ppc/index.htm**

Ref 3 Surface water & Groundwater Protection Guidance

- AQ11 (05) - Regulating water discharges from A2 Installations. Available via the Defra website **www.defra.gov.uk**

Ref 4 'Envirowise (formerly the Environmental Technology Best Practice Programme, ETBPP), Harwell International Business Centre, Didcot, Oxfordshire OX11 0QJ. Helpline 0800 585794. Good Practice Guides:

- GG109 Choosing cost effective pollution control
- GC049 Environmental management system improves performance

Ref 5 *HMIP Technical Guidance Note (Dispersion) D1,* 1993 The Stationery Office ISBN 0 11 752794 7

Ref 6 Water efficiency references available from Envirowise:

- GC22, Simple measures restrict water costs
- GG26, Saving money through waste minimisation: Reducing water use

Ref 7 Management, Resource Efficiency and Waste Minimisation References

- Defra/DTI - Changing Patterns - UK Government Framework for Sustainable Consumption and Production Sept 2003
- National Industrial Symbiosis Programme **www.nisp.org.uk/**
- Envirowise, GG025, Saving money through waste minimisation: Raw Material Use

Ref 8 Process Optimisation References

- Envirowise, ET193 Reducing hydrogen fluoride emissions in the whiteware sector.
- Envirowise, EN461 Key environmental performance indicators in the whiteware sector.

Ref 9 Waste & Resources Action Programme (WRAP), The Old Academy, 21 Horse Fair, Banbury, Oxon OX16 0AH. **helpline@wrap.org.uk**

Ref 10 *BS 5908: Code of Practice for Fire Precautions in the Chemical and Allied Industries*

Ref 11 *Environment Agency, Pollution Prevention Guidance Note* - Pollution prevention measures for the control of spillages and fire-fighting run-off, PPG 18, gives information on sizing firewater containment systems **(Environment Agency website)**

Ref 12 Monitoring Guidance **(Environment Agency website)**

- *M1 Sampling requirements for monitoring stack emissions to air from industrial installations,* Environment Agency July 2005
- *M2 Monitoring of stack emissions to air.* Environment Agency October 2004
- *Guidance on sampling and testing of wastes to meet landfill waste acceptance procedures*. Environment Agency Version 4.3a December 2003
- *MCERTS approved equipment link via* **http://www.environment-agency.gov.uk/business**" *How and why we regulate your business/Principles and approaches"*
- *Direct Toxicity Assessment for Effluent Control: Technical Guidance (2000), UKWIR 00/TX/02/07*

Abbreviations

BAT	Best Available Techniques
BOD	Biochemical Oxygen Demand
BREF	BAT Reference Document
CCA	Climate Change Agreement
CEM	Continuous Emissions Monitoring
CHP	Combined Heat and Power plant
CO_2	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
COSHH	Control of Substances Hazardous to Health
DPA	Direct Participation Agreement
EA	Environment Agency
EAL	Environment Assessment Level
ELV	Emission Limit Value
EMS	Environmental Management System
ETP	Effluent Treatment Plant
EU	European Union
EUETS	European Union Emissions Trading Scheme
EQS	Environmental Quality Standard
HCl	Hydrogen Chloride
H_2S	Hydrogen Sulphide
ITEQ	International Toxicity Equivalents
MCERTS	Monitoring Certification Scheme
MDI	Methyl Di-isocyanate
NIEHS	Northern Ireland Environment and Heritage Service
NO_2	Nitrogen Dioxide
PAH	Polyaromatic Hydrocarbon
SAC	Special Areas of Conservation
SECp	Specific Energy Consumption
SEPA	Scottish Environment Protection Agency
SO_2	Sulphur Dioxide
SPA	Special Protection Area
TEA	Triethylamine
TSS	Total Suspended Solids
TOC	Total Organic Carbon
VOC	Volatile Organic Compound
WAG	Welsh Assembly Government

Appendix 1: Summary of Changes

Reasons for the main changes are summarised below.

Table 11: Summary of changes

Section/ Paragraph/ Heading	Change	Reason	Comment
1. Introduction			
Table 1	compliance timetable amended	New provisions of note	
2. Emission limits and other provisions			
3. Techniques for pollution control			
Installation description and in-process controls			
3.10 Bulk powder	BAT provisions consolidated	BAT/industry good practice	Seven BAT clauses reduced to 4 in light of review information
Emissions Control			
3.185 Fugitive emissions to air, Fugitive emissions to surface water, sewer and groundwater	BAT provisions amended	BAT/industry good practice	
3.198 to 3.199 Odour	Inclusion of paragraph on assessment,	Restructuring Sector Guidance - extra guidance to regulators and operators	
BAT 78 – 80 Odour	BAT provisions for odour control	BAT/industry good practice	Principle of assessment and specific
Management			
3.203 and BAT 81	Additional BAT provision for using effective EMS	BAT/industry good practice	
Raw Materials			
3.211 and Table 7	Amended text and table for selection criteria for raw materials	Extra guidance to regulators and operators	
3.214	Guidance on sustainable consumption and production	Extra guidance to regulators and operators	Government Policy
BAT 92	BAT provision – establishing Benchmarks for efficiency in raw materials usage	BAT/industry good practice	
BAT 95	BAT provision – establishing benchmarks for water use	BAT/industry good practice	
Waste Handling			
BAT 97 - 100	BAT provisions consolidated	BAT/industry good practice	Seven BAT clauses reduced to 4 in light of review information
Waste re-use, recovery, recycling or disposal			
Bat 101 - 102	BAT provisions to annually review disposal options and to investigate new markets for waste recovery	BAT	Envirowise and WRAP guides given as reference
Energy			
3.233, BAT 108 and 109	Additional provisions for energy efficiency and supply techniques	BAT	

Accidents			
3.237	Inclusion of text for identification of the risks	Extra guidance to regulators and operators	
BAT 110 to 119	Additional provisions – specific measures for accident prevention	Industry good practice	
Noise and Vibration			
3.243 and Table 9	Additional text and new table identifying specific noise mitigation measures	BAT/industry good practice	
BAT 120	Additional provisions – identification of significant noise sources and implementing mitigation measures in Table 9.	BAT/industry good practice	
Monitoring			
3.246	Considering appropriateness when selecting test methods	Extra guidance to regulators and operators	
BAT 124	Reporting monitoring uncertainty	BAT	
BAT 140	Waste reporting	BAT/industry good practice	To assist in waste auditing to minimise the impact of waste to land
Information Provisions			
3.261 to 3.263, Tables 10a and 10b	Additional text and new tables identifying information and reporting provisions	Extra guidance to regulators and operators	
References	Amended reference list	New guidance available	
Appendix 1 and Table 11	New Appendix 1 included as a summary of changes		
Appendix 2	List of water test methods	Replacing Appendix 1	

Appendix 2: Some Common Monitoring Methods for Releases to Water

Table 12: Measurement methods for common substances to water

Determinand	Method	Detection limit	Valid for range mg/l	Standard
Suspended solids	Filtration through glass fibre filters	2 mg/l	20% 10-40	ISO 11929:1997, EN872 - Determination of suspended solids
COD	Oxidation with di-chromate	12 mg/l	20% 50-400	ISO 6060: 1989, Water Quality - Determination of chemical oxygen demand
BOD	Seeding with micro-organisms and measurement of oxygen content	3 mg/l O 0.5 mg/l O	0 – 6000 mg/l O 0.5 – 6 mg/l O 0-6 mg/l O extended by dilution	BS EN 1899-1:1998 BS EN 1899-2:1998 SCA blue book 130 ISBN 0117522120
Total hydrocarbon oil	Infra Red Absorption and Gravimetry 1983		0.2mg/l	SCA blue book 77 ISBN 0117517283
AOX	Adsorption on activated carbon and combustion		20% 0.4 - 1.0	ISO 9562: 1998, EN1485 - Determination of adsorbable organically bound halogens
Total N	Method using oxidative digestion with peroxodisulfate	0.02 mg/l.	0 – 5 ml/l, extended by dilution	BS EN ISO 11905-1:1998, BS 6068-2.62:1998 Water quality. Determination of nitrogen.
pH				BS 6068-2.50:1995, ISO 10523:1994
Turbidity				BS EN ISO 7027:2000 BS 6068-2.13:2000
Temperature				SCA temperature measurement for Natural, Waste and Potable Waters and other items of interest in the Water and Sewage Disposal Industry ISBN 0117520179
Metals	Inductively coupled plasma atomic emission spectroscopy			BS EN ISO 11885:1998, BS 6068-2.60:1998 Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy
Phenol index	By flow analysis (FIA and CFA)		0.01 – 1 mg/l	BS EN ISO 14402:1999 BS 6068-2.68:1999
Formalde-hyde				SCA The determination of formalde-hyde, other volatile aldehydes, ketones and alcohols in water
Ammonia		0.1 – 1 mg/l	0.1 – 10 mg/l	BS 6068: Section 2.11 1987, Method for the determination of ammonium: automated spectrometric detection