Integrated Pollution Prevention and Control (IPPC)

Secretary of State's Guidance for the A2 Ceramics Sector Including Heavy Clay, Refractories, Calcining Clay and Whiteware
Defra would like to acknowledge the work of the Environment Agency's Local Authority Unit in the drafting of this guidance note.
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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 3) on the integrated pollution control standards appropriate for the generality of new and existing A2 installations in the Ceramics including heavy clay, refractories, calcining clay and whiteware 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 4) 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 the Ceramics sector, including heavy clay, refractories, calcining clay and whiteware.

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 Ceramics 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, such as The Control of Pollution (Oil Storage) (England) Regulations 2001, SI 2954.
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 issued 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 listed 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 activities listed in the Regulations above plus the directly associated activities which have a technical connection and which may have an effect on pollution (see General Guidance Manual for a full definition, and explanation).

1.13 The following definitions should 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 operational constraints specified in the description of the installation). Capacity for batch production is averaged over the time taken to fire a batch.
• Multiple firings - multiple firings should not be counted each time when calculating the pro-
duction 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 refers to the following ceramic sectors under this A2 definition:

Heavy clay products includes:
• Clay bricks, including clamps
• Roof tiles and heavy clay floor tiles
• Vitrified clay pipes

Refractory products includes:
• Technical ceramics

Calcining clay

Whiteware products includes:
• Table ware, cookware and giftware
• Ceramic wall and floor tiles
• Sanitaryware

Review and Upgrading Periods

Existing installations or activities

1.15 For A2 installations, any requirements still outstanding from an existing upgrade programme
under LAPC should be completed, other than in exceptional circumstances and depending on
the activity and its history by the dates in the appropriate process guidance notes in the table
below.

Table 1: Existing compliance timetable

<table>
<thead>
<tr>
<th>Previous guidance - Secretary of State’s Guidance Note</th>
<th>Upgrading to those standards should have been completed by</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG3/2(95) amended by AQ6 (99) Manufacture of Heavy Clay Goods and Refractory goods</td>
<td>30 September 1997</td>
<td>Where process optimisation had achieved a reduction in fluoride emissions but were slightly above the 10mg/m³ limit at the end of 1999, a later deadline should have been considered by the local regulator</td>
</tr>
<tr>
<td>PG6/42(94) Bitumen and Tar Processes</td>
<td>1 October 2000</td>
<td></td>
</tr>
<tr>
<td>PG3/15(96) Mineral Drying and Cooling</td>
<td>1 April 1997</td>
<td></td>
</tr>
<tr>
<td>PG3/17(95) China and Ball Clay including the Spray Drying of Ceramics</td>
<td>1 April 1996</td>
<td>This includes calcining clay</td>
</tr>
</tbody>
</table>
1.16 The new provisions of this note and the dates by which compliance with these provisions is expected, are listed in Table 2 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 PG notes listed above, 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 2 below.

(2) Where standards or provisions in PG notes listed above have been deleted in this guidance note or where this guidance note specifies less stringent provisions than those in PG notes listed above, the new LA-IPPC permit should reflect this straightaway.

1.17 A programme for upgrading within the specified timescales, to those new/additional provisions in this guidance which involve significant improvement work, should be submitted to the relevant local authority regulator within 6 months of the date of issue of the permit.

Table 2: Compliance timetable

<table>
<thead>
<tr>
<th>Provisions</th>
<th>Reference</th>
<th>Compliance Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silos</td>
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</tr>
<tr>
<td>All new silo filtration plant - Design specification to operate to an emission standard of less than 10 mg/m³.</td>
<td>3.16</td>
<td>On commissioning</td>
</tr>
<tr>
<td>New silos - To be fitted with automatic protection systems</td>
<td>BAT 19</td>
<td>On commissioning</td>
</tr>
<tr>
<td>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.</td>
<td>BAT 16</td>
<td>Within 36 months of the publication of this note</td>
</tr>
<tr>
<td>Heavy clay and refractory goods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrestment equipment discharging externally with exhaust flow &gt;300 m³/min, other than that serving kilns or silos, has an emission limit of 50 mg/m³. There is a requirement for continuous monitoring and recording of the emissions.</td>
<td>Table 5: (Heavy clay)</td>
<td>Within 24 months of the publication of this note</td>
</tr>
<tr>
<td>All new and replacement arrestment plant, other than that serving kilns or silos, should be designed to achieve the limit of 50 mg/m³ for particulate matter when functioning correctly.</td>
<td>Table 5: (Heavy clay)</td>
<td>Prior to installation</td>
</tr>
<tr>
<td>All new or replacement silo filtration plant should be designed to operate to an emission standard of less than 10 mg/m³ for particulate matter.</td>
<td>Table 5: (Heavy clay)</td>
<td>Prior to installation</td>
</tr>
<tr>
<td>Refractory goods using petroleum pitch</td>
<td></td>
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<tr>
<td>Change in monitoring technique</td>
<td>Table 11: (footnote)</td>
<td>Within 12 months of the publication of this note</td>
</tr>
<tr>
<td>Spray drying of ceramics and calcining clay</td>
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<tr>
<td>Particulate matter - Drier, calciner 50 mg/m³</td>
<td>Table 5: (Calcining clay)</td>
<td>Within 5 years of the publication of this note</td>
</tr>
<tr>
<td>Particulate matter - Post - 1995 pulveriser drier 50 mg/m³</td>
<td>Table 5: (Calcining clay)</td>
<td>Within 5 years of the publication of this note</td>
</tr>
</tbody>
</table>
Arrestment plant handling dry dust which discharges externally with an exhaust flow greater than 100 m³/minute, other than from dryers, calciners or silos, should be designed to achieve an emission limit for particulate matter of 50 mg/m³.

Table 5: (Mineral drying and cooling) Where 50 mg/m³ 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 as practicable, which in most cases should be within 12 months of the publication of this note. New or replacement plant should be designed to this specification prior to installation.

Chloride - Scrubbed emissions 10 mg/m³

Table 5: (Calcining clay) Within 10 years of the publication of this note.

Fluoride - Calciner 5 mg/m³

Table 5: (Calcining clay) Within 10 years of the publication of this note.

Monitoring trends to be provided to regulators for emissions from dryers and calciners

When next providing monitoring results to regulator.

BS 3405 replaced by BS ISO 9096

Sampling points on new plant to meet BS ISO 9096 requirements

Table 11: On commissioning

1 This date will be reviewed in accordance with permit reviews below and in any case within 2 years of the publication of this note, in the light of any research into compliance with the emission limit values for chloride and fluoride emissions, with a view to considering whether compliance can and should be achieved earlier than 1/1/2012. This review may coincide with the review of the whole of this guidance following publication of the BREF

Mineral drying and cooling

Particulate matter emission limit of 50 mg/m³ for sand and mineral drying plant

Table 5: (Mineral drying and cooling) Within 24 months of the publication of this note

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

Table 5: (Oil burning) To meet the requirements of the Waste Incineration Directive
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 3: Summary of releases - Heavy clay and refractory products

<table>
<thead>
<tr>
<th>Source</th>
<th>Blending</th>
<th>Loading and unloading</th>
<th>Raw material stockpile</th>
<th>Hardstandings and storage areas, Roadways including haulage ways</th>
<th>Vehicle bodies and wheels</th>
<th>Material transfers, charges and discharges including hoppers, conveyors, silos and sheds</th>
<th>Size reduction</th>
<th>Driers</th>
<th>Kiln emissions</th>
<th>Wet scrubbers</th>
<th>Dry scrubbers</th>
<th>Waste oil combustion</th>
<th>Waste oil storage</th>
<th>Waste water treatment</th>
<th>Wet body preparation</th>
<th>Refractory impregnation with pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter / Total suspended solids</td>
<td>A</td>
<td>A</td>
<td>A</td>
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<td>A</td>
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<td>Odour</td>
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<td>Solid waste or sludge</td>
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<td>Liquid effluent</td>
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KEY
A - Release to Air, W - Release to Water, L - Releases to Land, * - Noise release
<table>
<thead>
<tr>
<th>Source</th>
<th>Release</th>
<th>Blending</th>
<th>Loading and unloading</th>
<th>Raw material stockpile</th>
<th>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</th>
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<tbody>
<tr>
<td>Particulate matter / Total suspended solids</td>
<td>A</td>
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<tr>
<td>Oxides of sulphur</td>
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<td>Chlorides</td>
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<td>Oxides of nitrogen</td>
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<td>Noise</td>
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<td>Lead</td>
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<td>Cadmium</td>
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<td>Cobalt</td>
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<td>Boron</td>
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<td>Zinc</td>
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**KEY**
2  Emission limits and other provisions

2.1  This section contains emission limits, mass release rates and other provisions 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  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. Thus, if a process comprises two kilns each of 15MW and three kilns each of 1.5MW, the two large kilns should be subject to the emission limits, but the smaller ones 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 that the kiln is operated 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.)

2.3  The requirement for no visible emissions applies to all kilns other than clamps.

2.4  Emissions from combustion processes should in normal operation be free from visible smoke and in any case should not exceed the equivalent of Ringelmann Shade 1 as described in British Standard BS 2742:1969.

2.5  All reasonably practicable steps should be taken to minimise the duration and visibility of visible emissions during start-up and shut down, and changes of fuel or combustion load.

2.6  All emissions to air other than steam or condensed water vapour should be free from droplets and from persistent mist and persistent fume.

2.7  There should be no offensive odour beyond the process boundary, as perceived by the regulator.

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

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>subject to paragraphs 3.227-3.238</td>
<td></td>
</tr>
<tr>
<td>Silos</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particulate matter</td>
<td>Silo inlet and outlets</td>
<td>No visible emission</td>
<td>Operator / driver Record start and finish times</td>
<td>Observations every delivery</td>
</tr>
<tr>
<td>Heavy clay and refractory goods except clamps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particulate matter</td>
<td>Kilns with a net rated thermal input of 2 MW or more</td>
<td>100 mg / m³</td>
<td>Isokinetic monitoring</td>
<td>Annually</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>Kilns with a net rated thermal input of less than 2 MW</td>
<td>No visible emission</td>
<td>Operator observations</td>
<td>At least daily when the kiln is in operation</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>All emissions to air</td>
<td>No visible emission</td>
<td>Operator observations</td>
<td>At least daily</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>Fugitive emissions - Whole site</td>
<td>No visible emission</td>
<td>As agreed with the regulator - to ensure that dust control measures are working</td>
<td>As agreed with the regulator</td>
</tr>
</tbody>
</table>
Table 5: Emissions to air associated with the use of BAT

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter</td>
<td>Arrestment equipment ¹ with exhaust flow &gt;300 m³/min (other than from kiln or silo arrestment plant)</td>
<td>50 mg / m³</td>
<td>Continuously recorded indicative monitoring</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Isokinetic sampling</td>
<td>At least once to demonstrate compliance, then as necessary to provide reference for the continuous indicative monitor</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>Arrestment equipment ¹ with exhaust flow &gt; 100 m³/min (other than from kilns and silo arrestment plant)</td>
<td>Designed to achieve 50 mg / m³</td>
<td>Continuous indicative monitoring to demonstrate that the arrestment equipment is functioning properly.</td>
<td>Continuously</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>Arrestment equipment ¹ with exhaust flow &gt; 100 m³/min (other than silo arrestment plant)</td>
<td>No visible emission</td>
<td>Operator observations; OR Continuous indicative monitoring to demonstrate that the arrestment equipment is functioning properly</td>
<td>At least daily Continuously</td>
</tr>
</tbody>
</table>

¹ Where the plant discharges to the external atmosphere

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen oxides ²</td>
<td>All new or substantially changed processes (with a net rated thermal input of 2 MW or more)</td>
<td>500 mg / m³</td>
<td>Manual extractive testing</td>
<td>Annually</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride (expressed as hydrogen chloride)</td>
<td>All new or substantially changed processes (with a net rated thermal input of 2 MW or more)</td>
<td>50 mg/m³</td>
<td>Manual extractive testing</td>
<td>Annually</td>
</tr>
<tr>
<td>Fluoride (expressed as hydrogen fluoride)</td>
<td>All kilns with a net rated thermal input of 2 MW or more.</td>
<td>10 mg / m³</td>
<td>Manual extractive testing</td>
<td>Annually</td>
</tr>
<tr>
<td>Sulphur oxides (expressed as sulphur dioxide)</td>
<td>New or substantially changed plant (with a net rated thermal input of 2 MW or more) Where low sulphur clays are used (&lt; / =0.12% w/w sulphur)</td>
<td>500 mg / m³</td>
<td>Manual extractive testing</td>
<td>Annually</td>
</tr>
<tr>
<td>Sulphur oxides (expressed as sulphur dioxide)</td>
<td>New or substantially changed plant (with a net rated thermal input of 2 MW or more) Where high sulphur clays are used (&gt;0.12% w/w sulphur)</td>
<td>2000 mg / m³</td>
<td>Manual extractive testing</td>
<td>Annually</td>
</tr>
</tbody>
</table>

Heavy clay goods - clamps

A clamp does not have a chimney, so it is impossible to monitor pollutant concentrations in the emissions which are direct to atmosphere. The limits to be applied to clamp 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 exept clamps’ in this Table.

### Whiteware Kilns under 2 MW

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter</td>
<td>Kilns with a net rated thermal input of less than 2 MW</td>
<td>No visible emission</td>
<td>Operator observations;</td>
<td>At least daily</td>
</tr>
</tbody>
</table>

### Whiteware site including all plant

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter</td>
<td>Fugitive emissions - Whole site</td>
<td>No visible emission</td>
<td>As agreed with the regulator - to ensure that dust control measures are working</td>
<td>As agreed with the regulator</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>All authorised emission points</td>
<td>No abnormal emission</td>
<td>Operator observations</td>
<td>At least daily</td>
</tr>
</tbody>
</table>

### Calcining clay and spray drying

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total particulate matter</td>
<td>Drier, calciner</td>
<td>50 mg / m³</td>
<td>To comply with BS ISO 9096</td>
<td>Twice a year</td>
</tr>
<tr>
<td>Total particulate matter</td>
<td>Pre-1995 pulveriser drier</td>
<td>100 mg / m³</td>
<td>To comply with BS ISO 9096</td>
<td>Twice a year</td>
</tr>
<tr>
<td>Total particulate matter</td>
<td>Post -1995 pulveriser drier</td>
<td>50 mg / m³</td>
<td>To comply with BS ISO 9096</td>
<td>Twice a year</td>
</tr>
<tr>
<td>Total particulate matter</td>
<td>All authorised emission points</td>
<td>No abnormal emission</td>
<td>Operator observations</td>
<td>At least daily</td>
</tr>
<tr>
<td>Total particulate matter</td>
<td>Arrestment equipment * with exhaust flow &gt; 300 m³ / min</td>
<td>50 mg / m³</td>
<td>Continuously recorded indicative monitoring</td>
<td>Continuously</td>
</tr>
<tr>
<td>Total particulate matter</td>
<td>Arrestment equipment * with exhaust flow &gt; 100 m³ / min</td>
<td>No visible emission, Equipment should be designed to achieve 50 mg / m³</td>
<td>Continuously recorded indicative monitoring to demonstrate equipment is functioning correctly</td>
<td>Continuously</td>
</tr>
<tr>
<td>Total particulate matter</td>
<td>Arrestment equipment * with exhaust flow &lt; 100 m³ / min</td>
<td>No visible emission</td>
<td>Operator observations; OR Continuous indicative monitoring to demonstrate that the arrestment equipment is functioning properly</td>
<td>At least daily Continuously</td>
</tr>
</tbody>
</table>

* Where discharge is to external environment (other than that serving dryers, calciners or silos)

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride (expressed as hydrogen chloride)</td>
<td>Emissions that have been scrubbed using chloride compounds.</td>
<td>10 mg / m³</td>
<td>BS EN 1911</td>
<td>Twice a year</td>
</tr>
<tr>
<td>Total Fluoride (expressed as hydrogen fluoride)</td>
<td>Calciner</td>
<td>5 mg / m³</td>
<td>ISO DIS 15713</td>
<td>Twice a year</td>
</tr>
</tbody>
</table>
### Mineral drying and cooling

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
</table>
| Total particulate matter     | Sand and mineral drying plant             | 50 mg / m³  | Either monitoring in accordance with the main procedural requirements of BS ISO 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 emission | Operator observations                                                      | At least daily        |
| Total particulate matter     | Arrestment equipment * with exhaust flow > 300 m³ / min | Designed to achieve 50 mg / m³ | Continuously recorded indicative monitoring | Continuously          |
| Total particulate matter     | Arrestment equipment * with exhaust flow > 100 m³ / min | Designed to achieve 50 mg / m³ | Continuous indicative monitoring to demonstrate that the arrestment equipment is functioning properly | Continuously          |
| Total particulate matter     | Arrestment equipment * with exhaust flow = / < 100 m³ / 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

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum pitch fume, as cyclohexane extractable fraction</td>
<td>All processes involving the heating of petroleum pitch excluding incinectors and storage</td>
<td>50 mg m³</td>
<td>Manual extractive test with filter at or below 42°C. See Notes on measuring petroleum pitch fume.</td>
<td>Annual</td>
</tr>
<tr>
<td>Petroleum pitch incinerators</td>
<td>Minimum temperature of 800°C with a residence time of at least 0.5 seconds.</td>
<td>From incinectors, bitumen monitoring is not required as long as time and temperature of secondary combustion is monitored and recorded along with visual and audible alarms</td>
<td>Annual calibration</td>
<td></td>
</tr>
</tbody>
</table>

* 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 1000°C may be needed

---

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

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Source</th>
<th>Limits</th>
<th>Monitoring</th>
<th>Monitoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>subject to paragraphs 3.227-3.238</td>
<td></td>
</tr>
</tbody>
</table>
Emissions to water associated with the use of BAT

2.8 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. The reagents used for precipitation may be hydroxide, sulphide or a combination of both, depending on the mix of metals present. It is also practicable in many cases to re-use treated water. The following table provides information regarding achievable levels associated with the use of wastewater treatment systems.

2.9 In all cases the effluent discharged from the installation must not give rise to a potential breach of an EQS or an EAL for the final receiving water, when taken with compliance with any water company permit.

Table 6: Emissions to water associated with the use of BAT for heavy clay and refractory goods, and whiteware

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Concentration, mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For heavy clay and refractory goods, and whiteware</strong></td>
<td></td>
</tr>
<tr>
<td>Suspended matter</td>
<td>20 - 60</td>
</tr>
<tr>
<td>BOD</td>
<td>30 - 40</td>
</tr>
<tr>
<td>Oil</td>
<td>0 - 5</td>
</tr>
<tr>
<td><strong>Additionally for whiteware</strong></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>6-10</td>
</tr>
<tr>
<td>temperature</td>
<td>ambient, but less than 43C</td>
</tr>
<tr>
<td>Pb</td>
<td>10</td>
</tr>
<tr>
<td>Zn</td>
<td>20</td>
</tr>
</tbody>
</table>
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.

Process description and in-process controls

Summary of activities

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 material 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 processes and their controls
- the significance of additional environmental impacts
- BAT box

Text common to all subsectors then restarts at Emissions control 3.162.

3.6 The Installation covers one or 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 ceramics industries

3.7 A2 ceramics 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, and includes
  - Tableware and ornamental ware
  - Sanitary ware
  - Ceramic wall and floor tiles

For information,

- The UK A1 ceramics sector 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 high 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, materials used for particular products, and production methods, leads 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 crushing 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
• Chamber dryers (intermittent)
• Chamber dryers (continuous)
• Vertical "basket" dryers
• Horizontal multi deck roller dryers
• Dehumidifying dryers
• Tunnel dryers

Firing of ware
• Intermittent (periodic) kilns
• Continuous kilns: chamber
• Continuous kilns: tunnel
• Roller hearth kilns
• Sliding bat kilns
• Clamps

Product Finishing
• Machining
• Wet grinding
• Drilling
• Sawing
• Polishing
• Carbon enrichment (refractories)
• Tumbling of facing bricks

Addition of auxiliary materials
• Jointing materials (pipes)
• Silicones / water repellents
• Lightweight plastic foams
• Carding and plating (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 pressurised the pressure relief valve should lift for safety reasons. If the pressure relief valve is 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, if it has to be 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 10mg/m³.

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 leaks 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 operation 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 material 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.

### Potential 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 (Sheet 1 of 2)

The operators should

1. Inform tanker drivers of the correct procedures to be followed concerning noise spillage leaks and dusty 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 7:
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.
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 a 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 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.

3.25 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.

Table 7: Frequency of visual inspection

<table>
<thead>
<tr>
<th>Filters</th>
<th>Frequency of visual inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitted with reverse jets</td>
<td>At least once a month</td>
</tr>
<tr>
<td>Fitted with mechanical shakers</td>
<td>At least once a week</td>
</tr>
<tr>
<td>Requiring manual shaking</td>
<td>Daily inspection or prior to any delivery being made if deliveries are not daily</td>
</tr>
</tbody>
</table>

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 a 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 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.

3.25 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 is a possible alternative. 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.

3.28 Clay is discharged into the clay preparation area. 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 is conveyed via a surge control feeder to mixers where it is adjusted to the required moisture content by the addition of water if necessary. Materials are also added at this stage such as materials to increase the tolerance of the material to the subsequent firing, or coke, or colourants. It then passes to the shaping operation.

3.31 If the shaping is by extrusion (extrusion / wire cut process), the material is passed through an extruder where it is formed into a column. The extruded 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 subjected 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 °C. Drying usually takes place over approximately a 24 hour period, but 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 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.
3.36 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 or more. The operational cycle of an intermittent kiln comprises both the 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.

3.37 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 are cooled 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. Envirowise guidance note GG166 Ref 5 provides detailed information relating to these techniques.

3.40 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 13 and Ref 14).

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

3.41 Primary measures to reduce fluoride emissions include

- Increasing the length of the kiln preheat section which increases the absorption 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 reabsorption of HF back into the product
- Setting patterns. Open setting patterns alter the absorption 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.

Potential 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 3.1: Flow diagram of a typical clay brick manufacturing process*

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**BAT (Sheet 1 of 2)**

**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 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.
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. There are thought to be 4 such firing processes in Sussex 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.
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:** Material preparation and transport

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**BAT**

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

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**Vitrified clay pipes**

3.50 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

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

3.52 Clay is extracted from the stockpile and tipped into a receiving 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 fillers takes place. Transfer of material may be by conveyor, in which case exposed sections are covered or enclosed.

3.53 Dust from the 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.)

3.54 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°C) 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.

3.55 Additional blue and calcined clay stores may provide a strategic reserve of material 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.

3.56 Clay from the raw material plant is conveyed via covered road vehicles or pneumatic conveyor systems to local storage 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 colorants, aesthetic improvers or materials to increase the tolerance of the material to the subsequent firing. It then passes to the extrusion or forming operation.

3.57 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.
3.58 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 subjected 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.

3.59 The green product is loaded onto 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.

3.60 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.

3.61 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.

3.62 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 several days or more. The operational cycle of an intermittent kiln comprises both the 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.

3.63 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

3.64 Clays usually contain 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.

3.65 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 important in stockpiling to reduce wind whipping of particulates.

3.66 There are various ways of keeping conveyor belts and the surrounding areas clean. Normal plain trough conveyor belts are used to transport material around the site, where external these belts are covered and at the termination points a scraper 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 operations

3.67 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 abatement.
3.68 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 13 and Ref 14).

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

3.69 Primary measures to reduce fluoride emissions include:

- Increasing the length of the kiln preheat section which increases the absorption 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 reabsorption of HF back into the product.
- Setting patterns. Open setting patterns alter the absorption 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, odour, smoke, products of combustion

Waste: Not significant

Energy: Significant

Accidents: Not significant

Noise: Material preparation and transport

<table>
<thead>
<tr>
<th>BAT</th>
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<tbody>
<tr>
<td>31</td>
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</tbody>
</table>

Refractory products

High temperature refractory products

3.70 The principal 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.

3.71 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.

3.72 Completed mixes are transferred to the feed hoppers 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.
3.73 The pressed (green) refractory bricks then undergo heat treatment. Resin and carbon bonded products are subject to low temperature (250 - 300 °C) tempering in a continuous, indirect fired kiln process. Fired basic, dolomite and sliding gate components undergo high temperature firing, within a 1455 - 1640 °C firing range. Both continuous tunnel kilns and intermittent kilns are used. All heating processes are natural gas fired.

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

3.75 The products are used primarily for steel and cement making processes.

Manufacture of refractory shapes using pitch

3.76 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

<table>
<thead>
<tr>
<th>Element</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
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</tr>
<tr>
<td>Land</td>
<td>Not significant</td>
</tr>
<tr>
<td>Air</td>
<td>Fluoride, particulate matter, odour, products of combustion</td>
</tr>
<tr>
<td>Waste</td>
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</tr>
<tr>
<td>Energy</td>
<td>Significant</td>
</tr>
<tr>
<td>Accidents</td>
<td>Not significant</td>
</tr>
<tr>
<td>Noise</td>
<td>Material preparation and deliveries</td>
</tr>
</tbody>
</table>

BAT

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

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

Tableware cookware and giftware

3.77 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

Body Preparation

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

3.80 The raw materials are apportioned and mixed with water to form a homogeneous suspension (body slip). The mixing process is 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.

3.81 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.

3.82 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

3.83 **Plastic Clay** Body slip is pumped, at high pressure into a filter press, which contains a series of cavitated 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 or settled before discharge.

3.84 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-cakes 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.

3.85 **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.)

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

**Forming**

3.87 **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 and 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.

3.88 **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.

3.89 **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.

3.90 Once the piece has dried sufficiently to allow it to be carefully handled without breaking or deformation, it is removed from the mould and dried further to the leather-hard stage.
3.91 **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.

3.92 **Isostatic Pressing** Clay granulate is fed pneumatically into a die assembly 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.

3.93 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 fettling and sponging. All trimmings and damaged pieces are usually recovered and recycled up to the white hard stage.

**Biscuit firing**

3.94 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.

3.95 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.

3.96 With intermittent kilns, firing takes place from ambient temperature up to top temperature and back to ambient temperature during the firing period. The operational cycle of an intermittent kiln comprises both the 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.

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

**Glazing**

3.98 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.

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

**Glost firing**

3.100 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 kilns and type of glaze used.

**Decoration**

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

3.102 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

3.103 The decorating techniques employed include:
- Hand painting
- Direct screen printing
- Total transfer printing
- Decalomania
Enamel firing

3.104 When a decoration 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 in either continuous or intermittent kilns.

Inspection and packing

3.105 The ware is then inspected for quality and packed ready for despatch.

Process Controls

3.106 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 two year review of this guidance, the following 3 paragraphs will be reassessed to see which, if any, of the techniques should be considered as BAT

3.107 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. Envirowise guidance note GG166 provides detailed information relating to these techniques.

3.108 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 13 and Ref 14).

3.109 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 reabsobtion of HF back into the product
• Setting patterns. Open setting patterns alter the absorption 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.

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: Material preparation and transport
Ceramic tiles

3.110 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 decoration (in some cases)
- Inspection and packing

Body Preparation incl spray drying

3.111 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 being produced.

3.112 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. eg fired wastes in outdoor uncovered yard, silos for fine dusts and some other materials
3.113 The raw materials are apportioned and mixed together in either dry form or in suspension in water. The harder minerals are ground in water in ball mills either separately or together with all the body materials. Ball mills are either continuous or batch processes.

3.114 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.

3.115 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**

3.116 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 Decoration**

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

3.118 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, clays 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.

3.119 Various methods are then used to apply decorative patterns to the glaze surface. The prints are usually in the form of a 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.

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

**Firing**

3.121 The glazed tiles are then conveyed and fed into kilns for firing. Kilns can either be intermittent kilns 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.

3.122 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**

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

**Process Controls**

3.124 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 two year review of this guidance, the following 3 paragraphs will be reassessed to see which, if any, of the techniques should be considered as BAT.

3.125 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 burner technology and low sulphur fuels. Fluoride emissions are controlled by in furnace process optimisation or by the use of scrubbers. Envirowise guidance note GG166 provides detailed information relating to these techniques.

3.126 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 13 and Ref 14).
3.127 Primary measures to reduce fluoride emissions include
  
  • Increasing the length of the kiln preheat section which increases the absorption 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 reabsorption of HF back into the product
  
  • Setting patterns. Open setting patterns alter the absorption 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.

### 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:** Material preparation and transport

### BAT

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

### Sanitaryware

3.128 The manufacture of sanitaryware is intrinsically the same process for all manufacturers:
  
  • Body preparation
  
  • Casting
  
  • Drying
  
  • Glazing
  
  • Gloss firing
  
  • Inspection
  
  • Re-firing out of spec product
  
  • Finishing, inspection & packing

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

#### Plaster Mould Manufacture

3.130 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

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

3.132 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.

3.133 The raw materials are apportioned 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.
3.134 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**

3.135 A porous plaster mould is filled 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.

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

**Pressure Casting**

3.137 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 mins. 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**

3.138 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**

3.139 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 clayware piece either by handspraying, robotic spraying or high volume machine spraying.

3.140 Any higher density glaze overspray is usually recovered and recycled. Lower density glaze washings can be recycled using microfiltration techniques.

**Glost Firing**

3.141 The dried glazed 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 descriptions are the same as for tableware.

**Re-Firing**

3.142 Out of specification articles which can be re-paired by re-spraying etc. are re-processed and taken through a second firing.

**Inspection & Packing**

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

**Process Controls**

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

3.145 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 burner technology and low sulphur fuels. Fluoride emissions are controlled by in furnace process optimisation or by the use of scrubbers. Envirowise guidance note GG166 provides detailed information relating to these techniques.

3.146 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 13 and Ref 14).
Primary measures to reduce fluoride emissions include:
- Increasing the length of the kiln preheat section which increases the absorption 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 reabsorption of HF back into the product.
- Setting patterns. Open setting patterns alter the absorption 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.

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: Material preparation and transport

Drying and Calcining of China clay

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 product to meet the customer’s requirements. It is used predominantly by the paper industry as a filler and as a coating, and in the manufacture of ceramics.

The different types of product are:
(1) As dried - most clay is sold in the form which it emerges from 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 road and rail wagons or specially adapted ships for use by the paper industry.
(4) Calcined clay for speciality products - multi-hearth kilns, if china clay is heated to temperatures above 450 °C 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 by calcining at different temperatures.

China clay to be calcined is usually milled to a fine powder before entering the top of a multi-hearth 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 500 °C to 1100 °C. 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 850 °C to 1500 °C 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 wagons and put into a tunnel drier for a period of 32 hours at 240°C and then into a tunnel calciner for 48 hours at a maximum temperature of 1500°C. 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 potter's 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 |

<table>
<thead>
<tr>
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</tr>
</tbody>
</table>

### Spray drying of ceramics

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

3.151 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.

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

3.153 A spray dryer 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 (500°C 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.
3.154 The waste gases exhausted from the spray dryer chamber contain fine particles of the material 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**

<table>
<thead>
<tr>
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<tbody>
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<tr>
<td>Noise</td>
<td>Some flue noise</td>
</tr>
</tbody>
</table>

**BAT**

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

### Mineral drying and cooling

3.155 Sand drying. When sand is quarried it typically has a moisture content of about 6%. For aesthetic purposes, different qualities 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.

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

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

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

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

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

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

**Potential environmental impact**

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<tr>
<td>Noise</td>
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</tr>
</tbody>
</table>
Emissions control

Point source emissions to air

3.162 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 or 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 odourous compounds from chilled products of combustion from intermittent kilns.

Dispersion and dilution of stack emissions

3.163 The basis upon which stack heights are calculated using HMIP Technical Guidance Note D1 (D1) (Ref 7) 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 emission 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 used to calculate the required stack height but alternative dispersion models may be used in agreement with the regulator. D1 relies upon the unimpeded vertical emission 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.

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 contributor to the problem.

An operator may chose to meet a tighter emission limit in order to reduce the required stack height.

3.164 For kilns under 2 MW for which numerical fluoride limits are not applied, the fluoride content should be measured in order to enable a stack height calculation to be made.

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

<table>
<thead>
<tr>
<th>BAT</th>
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<tbody>
<tr>
<td>44</td>
<td>All Bulk storage of dusty materials should be stored in silos, or in confined storage areas within buildings, or in fully enclosed containers / packaging.</td>
</tr>
<tr>
<td>45</td>
<td>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 and the cause of the problem rectified prior to further deliveries taking place. Tanker drivers should be informed of the correct procedure to be followed.</td>
</tr>
<tr>
<td>46</td>
<td>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.</td>
</tr>
</tbody>
</table>
3.166 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.

3.167 Liquid condensation on internal surfaces of flues and exhaust ducts might lead to corrosion and ductwork failure or to droplet emission.
- 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

3.168 Unacceptable emissions of droplets could possibly 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

3.169 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 discharged plume being affected by aerodynamic downwash

**BAT**

<table>
<thead>
<tr>
<th>All releases to air</th>
</tr>
</thead>
<tbody>
<tr>
<td>The operator should:</td>
</tr>
<tr>
<td>47 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.</td>
</tr>
<tr>
<td>48 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.</td>
</tr>
<tr>
<td>49 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.</td>
</tr>
<tr>
<td>50 Ensure that stack heights are sufficient to ensure adequate dispersion under normal conditions.</td>
</tr>
<tr>
<td>51 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.</td>
</tr>
<tr>
<td>52 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.</td>
</tr>
<tr>
<td>53 Investigate the cause and nature of any persistent visible emissions and provide a report to the regulator.</td>
</tr>
<tr>
<td>54 Ensure that emissions of water vapour are free from droplet fallout.</td>
</tr>
<tr>
<td>55 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.</td>
</tr>
</tbody>
</table>
3.170 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. In addition to the techniques below, guidance on cost-effective effluent treatment techniques can be found in ETBPP/Envirowise Guides (Ref 4).

3.171 The heavy clay and refractories sectors emit little if any process water other than as steam. The discharges of process water comprise principally:
- Discharges of boiler water blowdown
- Site drainage and stormwater;

3.172 The discharges of process water from the whiteware sector comprise principally:
- Discharges from effluent treatment
- Discharges of boiler water blowdown
- Compressor discharges

3.173 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

3.174 The nature of the receiving water should be taken into account, with regard to any pollutant released to this media. Irrespective of the receiving water, the adequacy of the plant to minimise emissions must be considered. Guidance on treatment of persistent substances can be found in Ref 9.
Local Authority Regulation

3.175 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."

Point source emissions to groundwater

3.176 The Groundwater Regulations for the UK came into force on 1 April 1999. If List I or List II substances are discharged to groundwater or may be discharged to groundwater then the Environment Agency will provide advice as part of their statutory consultation duties. For further guidance see chapter 31 in the General Guidance Manual.

Control of fugitive emissions to air

3.177 Common sources of fugitive emissions are:

- Particulate matter from:
  - Dry roadways
  - Storage, handling and use of powders and dusty materials;
  - Storage areas (e.g. bays, stockpiles etc.);
  - The loading and unloading of transport containers;
  - Transferring dry material from one vessel to another (e.g. mixing vessels or storage vessels, silos);
  - Conveyor systems for dry materials.

3.178 Dust emissions should be prevented whenever practicable. When this is not practicable arrestment should be used, or emissions should be controlled at source by measures agreed between the regulator and the operator, for example, avoidance of spillage and maintenance of high standards of housekeeping. Attention should be paid to preventing and cleaning up deposits of dust on external support structures and roofs in order to minimise wind entrainment of deposited dust.

3.179 All process buildings should be made as dust tight as is necessary to prevent visible emissions.

3.180 The preferred method removal of fine, dry waste from arrestment equipment is by return into the product. Where the material is to be disposed of then a wet removal system is preferred.

3.181 Spillages should normally be cleared up by wet handling methods. Dry handling of dusty spillages should not be permitted other than in fully enclosed buildings. (NB Dry handling of dusty spillages within fully enclosed buildings may not be acceptable under COSHH) Major spillages may be dealt with using a vacuum cleaning system. It should not normally be necessary for a vacuum cleaning system to be available on site at all times, provided that such equipment can be obtained in the event of a major spillage on the same day that it occurs, and measures to minimise emissions, such as dampening, are taken immediately.

3.182 Best practice in the transportation and handling of dusty materials is by methods which prevent or, where that is not practicable, minimise emissions to the air, for example by pipeline. The handling, transporting and stocking of finished goods may also give rise to dust emissions to the air if due care is not taken.
3.183 In designing a new process, minimising vehicle movement in the site layout will enable increased control of those areas which give rise to the potential for fugitive emissions.

3.184 Roadways in claypits are often unsurfaced. Where there are likely to be fugitive emissions then measures to prevent those emissions should be required.

3.185 Vehicle exhausts directed above the horizontal are preferred as these avoid the impact of the exhaust raising dust when travelling on internal roadways.

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

3.187 Operations should be controlled to minimise fugitive emissions.

**BAT**

59 For dust - employ the following general techniques where appropriate:

- cover skips and vessels
- keep outdoor stockpiles moist, ie if necessary use sprays, stockpile management techniques, windbreaks etc.
- use closed conveyors, pneumatic conveying (noting the higher energy needs), minimise drops
- regular housekeeping
- clean all process buildings regularly, according to a written maintenance programme, to minimise fugitive emissions
- clad externally all new buildings housing processing machinery with materials that can be readily cleaned
- where local exhaust ventilation is used, duct emissions to suitable arrestment plant.
- store dusty wastes in closed containers
- ensure that the method of collection of product or waste from dry arrestment plant minimises dust emissions
- where a dry system is used, discharge the material into closed vessels fitted with an effective dust collection system and consider its final mode of disposal
- clean up promptly all spillages which may give rise to dust emissions

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

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

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

63 Roadways in normal use and any other area where there is regular movement of vehicles should have a consolidated surface capable of being cleaned. They should be kept clean in order to prevent or minimise dust emissions. They should be kept in good repair.
Fugitive emissions to surface water, sewer and groundwater

3.188 Operations should be controlled so as to minimise fugitive emissions.

**BAT (Sheet 1 of 2)**

64 With regard to **subsurface structure**, the operator should:
- establish and record the routing of all installation drains and subsurface pipework
- identify all subsurface sumps and storage vessels
- engineer systems to minimise leakages from pipes and ensure swift detection if they do occur, particularly where hazardous (i.e. listed) substances are involved
- provide, in particular, secondary containment and/or leakage detection for such subsurface pipework, sumps and storage vessels
- establish an inspection and maintenance programme for all subsurface structures, e.g. pressure tests, leak tests, material thickness checks or CCTV

65 For **surfacing**, the operator should:
- ensure that all operational areas are equipped with an impervious surface, spill containment kerbs, sealed construction joints, and connection to a sealed drainage system unless the operator justifies that this is not necessary to the satisfaction of the regulator.
- keep records of the design and condition of the surfacing of all operational areas - relevant information may include, as appropriate, capacities, thicknesses, falls, material, permeability, strength/reinforcement, and resistance to chemical attack
- have an inspection and maintenance programme of impervious surfaces and containment kerbs
- justify where operational areas have not been equipped with:
  - an impervious surface
  - spill containment kerbs
  - sealed construction joints
  - connection to a sealed drainage system

66 The operator should ensure that all tanks containing liquids whose spillage could be harmful to the environment are contained. The operator should ensure that all bunds:
- are impermeable and resistant to the stored materials
- have no outlet (that is, no drains or taps) and drain to a blind collection point
- have pipework routed within bunded areas with no penetration of contained surfaces
- are designed to catch leaks from tanks or fittings
- have a capacity of at least 110% of the largest tank *
- are visually inspected weekly and any contents pumped out or otherwise removed under manual control after checking for contamination
- where not frequently inspected, are fitted with a high-level probe and an alarm as appropriate
- have an annual maintenance inspection (normally visual but extending to water testing where structural integrity is in doubt)

67 All sumps should:
- be impermeable and resistant to stored materials
- be subject to regular visual inspection agreed with the regulator and any contents pumped out or otherwise removed after checking for contamination

* A Code of Practice on the use and storage of solvents is currently being drawn up and will be published on the Defra website, www.defra.gov.uk/environment/water/ground/solvents/index Where the Code, when published, contains anything more stringent as regards bunding, account should be taken of it.
3.189 Chapter 17 of the General Guidance Manual provides guidance on controlling odour from installations and the information required in an application.

3.190 Implementation of the best available techniques and the emission limit values and provisions of this note should ensure that offensive odours are not perceived beyond the site boundary, other than where unavoidable plume grounding occurs. It may be necessary to include additional controls to avoid offensive odours, for example where local meteorological conditions frequently lead to poor dispersion conditions.

3.191 The locality will influence the assessment of the potential for odour impact, for example, 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. In these circumstances it is expected that the operations should be optimised to minimise odour emissions and also that effective process management is applied. Assessment of the potential for offensive odour beyond the site boundary should take account of all predicted wind directions and weather conditions, which are typical of the location in question.

3.192 When for whiteware, decals are fired, odour can be emitted. If the odour cannot be controlled satisfactorily using process controls, then an afterburner or other abatement plant should be fitted.

Management

3.193 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.

3.194 An effective Environmental Management System (EMS) will help the operator to maintain compliance with regulatory requirements and to manage other significant environmental impacts.

3.195 **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

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**Odour**

### 68 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 to prevent overfilling
- have delivery connections located within a bunded area, fixed and locked when not in use
- have their integrity inspected, recorded and documented, particularly where corrosive substances are involved. These inspections should be included in the maintenance schedule

### 69 Storage areas and containers should be designed and operated to minimise the risk of fugitive releases to surface water, sewer and groundwater, in particular:
- storage areas should be located away from watercourses and should be protected against vandalism
- the maximum storage capacity of storage areas should be stated and not exceeded
- the maximum storage period for containers should be specified
- storage areas and silos should be inspected at least once a week to check for signs of leakage or potential leakage

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**Operations and maintenance**

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Ceramics Sector Guidance Note IPPC SG7 | Issue 1.0 | Published in March 2004
3.196 **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 plant.

3.197 **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.

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**BAT**

**Operations and maintenance**

70 Effective operational and maintenance systems should be employed on all aspects of the installation whose failure could impact on the environment, in particular there should be:
- documented operational control procedures
- a documented preventative maintenance schedule, covering all plant whose failure could lead to impact on the environment, including major ‘non productive’ items such as tanks, pipework, retaining walls, bunds, ducts and filters; this should be reviewed and updated annually
- documented procedures for monitoring emissions

71 The regulator should be provided with a list of key process equipment and abatement equipment. Such equipment should be provided with alarms or other warning systems 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.

72 Essential spares and consumables should be held on site or be available at short notice from suppliers, so that plant breakdown can be rectified rapidly.

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

74 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.

**Audits**

75 All audit records of raw material usage, water usage, energy usage and waste production should be referenced to annual production.

**Competence and training**

76 Training systems, covering the following items, should be in place for all relevant staff:
- awareness of the regulatory implications of the permit
- awareness of all potential environmental impacts under normal and abnormal circumstances
- awareness of the procedures for dealing with a breach of the permit conditions
- prevention of accidental emissions and action to be taken when accidental emissions occur
- awareness of all operating procedures

77 The skills and competencies necessary for key posts (which may include contractors and those purchasing equipment and materials) should be documented and records of training needs and training received for these posts maintained.

78 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 conformity**

79 There should be written procedures for investigating incidents, (and near misses) including identifying suitable corrective action and following up.
Raw Materials

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

3.199 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

3.200 The raw materials used in the sector vary considerably, both with location and product. Process optimisation is the technique for all processes either to comply with emission limit values or to minimise the use of abatement materials and the production of wastes. The following issues in Table 8: should be considered when selecting raw materials:

Table 8: Raw material selection

<table>
<thead>
<tr>
<th>Raw material</th>
<th>Selection criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>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 dependent on the concentration of fluoride in the clay.</td>
</tr>
<tr>
<td>Pore forming agents</td>
<td>Suitability for product, effect on level of pollution emitted</td>
</tr>
<tr>
<td>Mineral additives eg lime-stone for ceramic tiles</td>
<td>Suitability for product, effect on level of pollution emitted</td>
</tr>
<tr>
<td>Additives to enhance product aesthetics</td>
<td>Suitability for product, effect on level of pollution emitted</td>
</tr>
<tr>
<td>Fluxes and binders</td>
<td>Suitability for product, effect on level of pollution emitted</td>
</tr>
<tr>
<td>Water</td>
<td>Identify most suitable source (consider recycled sources)</td>
</tr>
<tr>
<td>Fuels</td>
<td>Natural gas or similar is preferred; eg electricity for whiteware. If oil is used, then: Sulphur content should be minimised. Sulphur Content of Liquid Fuels Regulations (England and Wales) Regulations 2000 SI1460 limits sulphur in oil and gas oil. Waste or recovered oil contain metals and other contaminants and will be subject to the Waste Incineration Directive</td>
</tr>
<tr>
<td>Colourant</td>
<td>Suitability for product, effect on level of pollution emitted, including sulphur content of colourant</td>
</tr>
</tbody>
</table>

Additionally for refractories

<table>
<thead>
<tr>
<th>Magnesias, aluminas and chrome minerals</th>
<th>Suitability for product, effect on level of pollution emitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal additions</td>
<td>Suitability for product, effect on level of pollution emitted</td>
</tr>
</tbody>
</table>
Waste minimisation (optimising the use of raw materials)

3.201 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”.

3.202 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.

3.203 Key operational features of waste minimisation will 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

3.204 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.

3.205 The use and fate of all materials should be mapped onto a process flow diagram using data from the raw materials inventory and other company data as appropriate. Data should be incorporated for each principal stage of the operation in order to construct a mass balance for the installation. The mass balance can then be used to identify opportunities for improvements.
Water use

3.206 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.

3.207 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.

Advice on cost-effective measures for minimising water use can be found in Ref 5.

3.208 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

3.209

- Clean water is needed in glaze makeup
- Some recycled water can be used in tile body eg from body raw material, spray driers, wet scrubbers

BAT

81 The operator should carry out a waste minimisation audit at least as frequently as the review period of the 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.

82 If an audit has not been carried out in the 2 years prior to submission of the application then the first audit should take place within 18 months of the issue of the permit.

83 Specific improvements resulting from the recommendations of audits should be carried out within a timescale approved by the regulator.

84 The operator should carry out a regular review of water use (water efficiency audit). Where one has not been carried out recently, an initial comprehensive audit should be carried out at the earliest opportunity. Audits should be at least as frequent as the IPPC permit reviews.

85 Using this information, 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.

86 The volume of mains and abstracted water used in the activities should be directly measured when the installation is operating once a day for at least a fortnight and there after, once a week with an annual exercise taking daily measurements for at least a fortnight. All measurements should be recorded and the records held on site.
Waste handling

3.210 Good segregation of materials is essential to facilitate opportunities for recovery, recycling and re-use.

3.211 The most important wastes are:
- Off spec or broken product
- Refractory waste from incinerators, dryers and combustion chambers inc ceramic fibre
- Scrubber waste
- Particulate matter collected in bag or cartridge filters
- Glaze
- Water treatment waste solids inc lead bearing solids
- Plaster of paris moulds
- General inert industrial waste, and small quantities of waste oil.

3.212 Whiteware waste also includes
- Glaze
- Water treatment waste solids inc lead bearing solids
- Plaster of paris moulds

3.213 Waste should be recovered wherever practicable.

<table>
<thead>
<tr>
<th>BAT</th>
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<tr>
<td>87</td>
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</table>
Waste re-use, recovery, recycling or disposal

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

3.215 Table 9 summarises the routes of the various waste streams from a typical Ceramics 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.

Table 9: Solid waste stream routes

<table>
<thead>
<tr>
<th>Process waste stream route</th>
<th>Fate</th>
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<tbody>
<tr>
<td><strong>For heavy clay and refractories</strong></td>
<td></td>
</tr>
<tr>
<td>Unfired waste</td>
<td>Re-use</td>
</tr>
<tr>
<td>Fired waste</td>
<td>re-use, recycle, recover, crush for roadways, landfill</td>
</tr>
<tr>
<td>Dust extraction dust</td>
<td>Landfill</td>
</tr>
<tr>
<td>Dry scrubber waste</td>
<td>Re-use if it can be ground up and fed back, otherwise landfill</td>
</tr>
<tr>
<td>Packaging waste</td>
<td>Recycle, recover</td>
</tr>
<tr>
<td>Refractory waste</td>
<td>Crush for roadways landfill</td>
</tr>
<tr>
<td>Ceramic fibre</td>
<td>Bag and landfill</td>
</tr>
<tr>
<td><strong>For whiteware</strong></td>
<td></td>
</tr>
<tr>
<td>Unfired waste</td>
<td>Re-use, landfill contaminated waste</td>
</tr>
<tr>
<td>Fired waste</td>
<td>Re-use (or send for re-use), recycle, recover, crush for roadways, landfill</td>
</tr>
<tr>
<td>Dust extraction dust</td>
<td>Re-use, landfill</td>
</tr>
<tr>
<td>Dry scrubber waste</td>
<td>Reuse if it can be ground up and fed back, otherwise landfill</td>
</tr>
<tr>
<td>Packaging waste</td>
<td>Recycle, recover</td>
</tr>
<tr>
<td>Refractory waste</td>
<td>Crush for roadways landfill</td>
</tr>
<tr>
<td>Ceramic fibre</td>
<td>Bag and landfill</td>
</tr>
<tr>
<td>Glaze</td>
<td>Reclaim and re-use, settle press filter and landfill</td>
</tr>
<tr>
<td>Plaster moulds</td>
<td>Send to cement industry or landfill</td>
</tr>
<tr>
<td>Hydraulic oils</td>
<td>Send to oil treatment</td>
</tr>
<tr>
<td>Sludge</td>
<td>Landfill</td>
</tr>
</tbody>
</table>

**BAT**

88 The operator should carry out an annual review to demonstrate that the best environmental options are being used for dealing with all waste from the installation.
Energy

3.216 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) or a Direct Participation Agreement (DPA) with the Government.

or

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

Basic energy efficiency requirements

3.217 The requirements of this section are basic, low cost, energy standards that apply whether or not a CCA or DPA is in force for the installation.

<table>
<thead>
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</table>

Additional energy efficiency requirements

3.218 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.

<table>
<thead>
<tr>
<th>BAT</th>
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<tbody>
<tr>
<td>Energy efficiency techniques</td>
</tr>
<tr>
<td>93</td>
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</tbody>
</table>

| Energy supply techniques |
| 94  | The following techniques should be considered: |
|     | • use of Combined Heat and Power (CHP) |
|     | • generation of energy from waste |
|     | • use of less polluting fuels |
Accidents

3.219 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

3.220 Further guidance can be found in chapter 20 of the General Guidance Manual.

**Identification of the hazards**

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

- transfer of substances (e.g. loading or unloading from or to containers/silos or storage tanks)
- overfilling of containers/silos or tanks
- failure of plant and/or equipment (e.g. extraction fans or pumps, over-pressure of storage silos and pipework, blocked drains)
- failure of containment (e.g. bund and/or overfilling of drainage sumps)
- fires and problems arising from fighting fires such as failure to contain firewaters
- making the wrong connections in drains or other systems
- preventing incompatible substances coming into contact
- unwanted reactions and/or runaway reactions
- emission of an effluent before adequate checking of its composition has taken place
- steam main issues
- vandalism
- vehicle movements

**Measures to reduce the risks (identified by risk assessment)**

3.222 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

3.223 **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 redundancy or standby plant with maintenance and testing to the same standards as the main plant
• 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
• suitable barriers to prevent damage to equipment from the movement of vehicles, as appropriate, having regard to a site-specific assessment of risks
• 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

Noise and Vibration

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

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

3.226 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 noise problems. 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.

BAT

Accidents/incidents/non conformance

95 There should be written procedures for investigating incidents and near misses, including identifying suitable corrective action and following up.

96 The operator should maintain an accident management plan that identifies the hazards, assesses the risks and identifies the measures required to reduce the risk of potential events or failures that might lead to an environmental impact. The plan should identify:
• the actions to be taken to minimise these potential occurrences; and
• the actions to deal with such occurrences so as to limit their consequences

97 In the case of abnormal emissions arising from an accident, such as a spillage for example, the operator should:
• investigate immediately and undertake remedial action as soon as practicable
• promptly record the events and actions taken
• ensure the regulator is made aware, as soon as practicable

Noise and Vibration

98 The operator should employ basic good practice measures for the control of noise, in particular:
• identification of key plant and equipment with the potential to give rise to noise nuisance
• documented maintenance systems for the identified key plant and equipment
Monitoring

3.227 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. The specific monitoring requirements with respect to emissions to air are described in Table 5.

Standards for monitoring equipment and procedures

3.228 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

3.229 The analytical methods given in Table 5: Table 10: and Table 11: should normally be used. In the event of other substances needing to be monitored, standards 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)

3.230 Further guidance on standards for monitoring gaseous releases relevant to IPPC is given in the Technical Guidance Note M4 (Monitoring) (see Ref 9. A series of updated Guidance Notes covering this subject is currently in preparation. This guidance specifies manual methods of sampling and analysis, which will also be suitable for calibration of continuous emission monitoring instruments. Further guidance relevant to water and waste is available from the publications of the Standing Committee of Analysts. See http://dwi.gov.uk/regs/pdf/scabb202.pdf

3.231 If in doubt the operator should consult the regulator.

Monitoring and sampling protocols

3.232 Where monitoring is needed the operator should address the following:
- determinands to be monitored
- monitoring strategy and selection of monitoring points
- monitoring methods and procedures (selection of Standard Reference Methods)
- reference conditions and averaging periods
- measurement uncertainty of the proposed methods and the resultant overall uncertainty
- drift correction
- quality assurance (QA) and quality control (QC) protocols, 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
- the accreditation held by samplers and laboratories or details of the people used and the training/competencies
Monitoring frequency

3.233 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.

3.234 Emission flow rates must be consistent with good operating practice and meeting the requirements of the legislation relating to workplace safety.

3.235 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/m³, against an emission limit of 50 mg/m³ 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/m³ when the limit is 50 mg/m³ might not qualify for a reduction in monitoring

3.236 Consistent compliance should be demonstrated using the results from 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.

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

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

Monitoring emissions to air

3.239 The reference conditions for emission limits in Emissions to air associated with the use of BAT are:
   • for combustion of waste oil, the reference conditions required by the Waste Incineration Directive must be applied
   • for other kiln emissions, the reference conditions are 273K, 101.3 kPa, 18% oxygen measured dry, and averaged over the firing cycle of the kiln
   • all other emissions:, 273K, 101.3 kPa without correction for water vapour content,

To convert measured values to reference conditions, see Technical Guidance Note M2 (Ref 9) for more information.

3.240 Where waste oil is burnt the monitoring requirements of the Waste Incineration Directive must be applied

3.241 There are specific design requirements that apply to arrestment plant, and monitoring and recording requirements for emissions from arrestment plant handling dry dust which discharges externally, other than that serving kilns or silos

3.242 In the case of water based abatement systems, continuous monitoring and recording of the conductivity of the scrubbing liquor in the abatement systems can be used as a surrogate for total fluoride (expressed as HF) emissions which are released to the atmosphere. Such measurements can be used as a valuable management tool in providing a continuous estimate of total fluoride (expressed as HF) emissions which are released to the atmosphere from the process. Continuous monitoring can also be used to identify any trends in emissions, for example, that emissions are gradually increasing, which may indicate a need for maintenance. It can also be used with or without continuous recording to trigger an alarm where there is a sudden increase in emissions, for example, if arrestment plant fails.
Monitoring emissions to water

3.243 The appropriateness of the emission benchmarks 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)

3.244 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


Monitoring of process variables

3.246 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:
- keeping inventories of materials used and disposed of.
- monitoring temperature or pressure where relevant, for example pressure drop across bag filters.
- plant efficiency monitoring.

<table>
<thead>
<tr>
<th>BAT (Sheet 1 of 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monitoring and reporting</strong></td>
</tr>
<tr>
<td>99 The need for and scope of testing and the frequency and time of sampling depend on local circumstances, operational practice, and the scale of operation. As part of proper supervision 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:</td>
</tr>
<tr>
<td>- current records should be kept on site and be made available for the regulator to examine</td>
</tr>
<tr>
<td>- records should be kept by the operator for at least two years</td>
</tr>
<tr>
<td>100 The regulator needs to be informed of monitoring to be carried out and the results. The results should include process conditions at the time of monitoring.</td>
</tr>
<tr>
<td>101 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</td>
</tr>
<tr>
<td>102 The results of non-continuous emission testing should be forwarded to the regulator within 8 weeks of the completion of the sampling.</td>
</tr>
</tbody>
</table>
Adverse results from any monitoring activity (both continuous and non-continuous) should be investigated immediately. The operator should ensure that:

- the cause has been identified and corrective action taken
- as much detail as possible is recorded regarding the cause and extent of the problem and the action taken to rectify the situation
- re-testing to demonstrate compliance is carried out as soon as possible, and
- the regulator is notified

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 air. Such problems may arise within the process itself or with the abatement plant, for example.

In the case of abnormal emissions, malfunction or breakdown leading to abnormal emissions:

- investigation and remedial action should be undertaken immediately
- the process or activity should be adjusted to minimise those emissions; and
- the events and actions taken should be promptly recorded
- In the case of non-compliance causing immediate danger to human health, operation of the activity should be suspended

The regulator should be informed without delay:

- if there is an emission that is likely to have an effect on the local community; or
- in the event of the failure of key abatement plant, for example, bag filtration plant or scrubber units
- if continuous monitoring shows an emission concentration exceeding double the limit value

Care is needed in the design and location of sampling systems in order to obtain representative samples for all release points.

- sampling points on new plant should be designed to comply with the British or equivalent standards. e.g. BS ISO 9096: 2003, BS EN 13284-1or BS ISO 12141:2002 for sampling particulate matter in stacks
- the operator should ensure that adequate facilities for sampling are provided on stacks or ducts
- where monitoring is not in accordance with the main procedural requirements of the relevant standard, deviations should be reported as well as an estimation of any error invoked

Where continuous monitoring is required by the permit it should be carried out as follows:

- all continuous monitoring readings should be on display to appropriately trained operating staff
- 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
- all continuous monitors should be operated, maintained and calibrated (or referenced) in accordance with the manufacturers' instructions, which should be made available for inspection by the regulator. The relevant maintenance and calibration (or referencing) should be recorded
- all new continuous monitoring equipment should be designed for less than 5% downtime over any 3-month period
109 Care is needed in the design and location of sampling systems in order to obtain representa-
tive samples for all release points.
   • sampling points on new plant should be designed to comply with the British or equivalent
     standards. e.g. BS ISO 9096: 2003, BS EN 13284-1or BS ISO 12141:2002 for sampling
     particulate matter in stacks
   • the operator should ensure that adequate facilities for sampling are provided on stacks or
     ducts
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     vant standard, deviations should be reported as well as an estimation of any error invoked

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     accordance with the manufacturers’ instructions, which should be made available for
     inspection by the regulator. The relevant maintenance and calibration (or referencing)
     should be recorded
   • all new continuous monitoring equipment should be designed for less than 5% downtime
     over any 3-month period

Monitoring and reporting of emissions to air

111 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 work-
place environment.

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

113 Dilution air may be added for waste gas cooling or improved dispersion where justified, but this
should not be considered when determining the mass or concentration of the pollutant in the
waste gases.

114 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.

115 Calibration and compliance monitoring should meet the following requirements as appro-
priate. No result should exceed the emission concentration limits specified, except where either:
   (a) data is obtained over at least 5 sampling hours in increments of 15 minutes or less; or
   (b) at least 20 results are obtained where sampling time increments of more than 15 minute
     are involved: AND in the case of (a) or (b)

   (c) no daily mean of all 15-minute mean emission concentrations should exceed the speci-
     fied emission concentration limits during normal operation (excluding start-up and shut-
     down); and
   (d) no 15-minute mean emission concentration should exceed twice the specified emission
     concentration limits during normal operation (excluding start-up and shut-down).

116 Where continuous quantitative monitoring is undertaken, compliance with (c) and (d) above
should be demonstrated on a daily basis.

117 Visual and olfactory assessments of emissions should be made frequently, and at least once a
day during operations. The time, location and result of these assessments should be
recorded.
Where, in the opinion of the regulator, there is evidence of airborne dust from the process off the site, the operator should make their own inspection and assessment, and where necessary undertake ambient monitoring with the aim of identifying those process operations giving rise to the dust. The monitoring may either be by a British Standard method or by a method agreed with the regulator. In these situations, determination of wind direction may be required. Once the source of the emission is known, corrective action should be taken without delay.

This paragraph only applies to plant oil fired with non-waste oil:
- for direct fired plant, during the annual stack gas sampling for metals, chlorides, sulphur and fluorides, a well blended representative sample of the oil being burnt should also be sampled and analysed independently. The proportions of metals, chlorides, sulphur and fluorides that are retained in the appliance and subsequent arrestment plant should then be established.

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 3.229. 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 of water to sewer**

The appropriateness of the emission benchmarks 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

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.

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**

The following should be monitored and recorded:
- the physical and chemical composition of the waste
- its hazard characteristics
- handling precautions and substances with which it cannot be mixed
References

Environment Agency documents referred to below are available from the Environment Agency website [http://www.environment-agency.gov.uk](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](http://www.sepa.org.uk), or the NIEHS website [www.ehsni.gov.uk](http://www.ehsni.gov.uk)

Ref 1 IPPC Reference Document on Best Available Techniques in the Ceramics Industry European Commission [http://eippcb.jrc.es](http://eippcb.jrc.es) (This document is not yet available. During its production, drafts will be available)


Ref 5 Water efficiency references:

- ETBPP, Simple measures restrict water costs, GC22
- ETBPP, Effluent costs eliminated by water treatment, GC24
- ETBPP, Saving money through waste minimisation: Reducing water use, GG26
- ETBPP (is now Envirowise) Helpline 0800 585794


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

Ref 8 BS 5908: Code of Practice for Fire Precautions in the Chemical and Allied Industries

Ref 9 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 [EA website](http://www.environment-agency.gov.uk/epns)

Ref 10 Monitoring Guidance (EA website)

- M1 Sampling requirements for monitoring stack emissions to air from industrial installations, Environment Agency July 2002
- M2 Monitoring of stack emissions to air. Environment Agency November 2002
- Direct Toxicity Assessment for Effluent Control: Technical Guidance (2000), UKWIR 00/TX/02/07

Ref 11 "Policy and Practice for the Protection of Groundwater" (PPPG)(EA website)

Ref 12 GG166 Reducing fluoride emissions in brick, tile and pipe manufacture, Envirowise Helpline 0800 585794

Ref 13 NC 178 Cost effective reduction of fluoride air emissions through process optimisation, Envirowise Helpline 0800 585794

Ref 14 Guidance on introducing an environmental management system for Ceramics, British Ceramics Confederation 2001

Ref 15 GG292 Managing water use and benchmarking in the brick and heavy clay sectors, Envirowise Helpline 0800 585794

Abbreviations

<p>| BAT | Best Available Techniques – see IPPC General Guidance Manual or the Regulations for further definition |
| BOD | Biochemical Oxygen Demand |
| BREF | BAT Reference Document |
| CEM | Continuous Emissions Monitoring |
| CHP | Combined Heat and Power plant |
| COD | Chemical Oxygen Demand |
| EA | Environment Agency |
| ELV | Emission Limit Value |</p>
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMS</td>
<td>Environmental Management System</td>
</tr>
<tr>
<td>ETP</td>
<td>Effluent Treatment Plant</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EQS</td>
<td>Environmental Quality Standard</td>
</tr>
<tr>
<td>ITEQ</td>
<td>International Toxicity Equivalents</td>
</tr>
<tr>
<td>MCERTS</td>
<td>Monitoring Certification Scheme</td>
</tr>
<tr>
<td>NIEHS</td>
<td>Northern Ireland Environment and Heritage Service</td>
</tr>
<tr>
<td>SAC</td>
<td>Special Areas of Conservation</td>
</tr>
<tr>
<td>SECp</td>
<td>Specific Energy Consumption</td>
</tr>
<tr>
<td>SEPA</td>
<td>Scottish Environment Protection Agency</td>
</tr>
<tr>
<td>SPA</td>
<td>Special Protection Area</td>
</tr>
<tr>
<td>TSS</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td>TOC</td>
<td>Total Organic Carbon</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compounds</td>
</tr>
</tbody>
</table>
## Appendix 1: Some common monitoring and sampling methods

### Table 10: Measurement methods for common substances to water

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Method</th>
<th>Detection limit</th>
<th>Valid for range</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Uncertainty</td>
<td>mg/l</td>
<td></td>
</tr>
<tr>
<td><strong>Suspended solids</strong></td>
<td>Filtration through glass fibre filters</td>
<td>1 mg/l</td>
<td>10-40</td>
<td>ISO 11929:1997, EN872 - Determination of suspended solids</td>
</tr>
<tr>
<td><strong>COD</strong></td>
<td>Oxidation with di-chromate</td>
<td>12 mg/l</td>
<td>50-400</td>
<td>ISO 6060: 1989, Water Quality - Determination of chemical oxygen demand</td>
</tr>
<tr>
<td><strong>BOD5</strong></td>
<td>Seeding with micro-organisms and measurement of oxygen content</td>
<td>2 mg/l</td>
<td>5-30</td>
<td>ISO 5815: 1989, Water Quality Determination of BOD after 5 days, dilution and seeding method EN 1899 (BOD 2 Parts)</td>
</tr>
<tr>
<td><strong>AOX</strong></td>
<td>Adsorption on activated carbon and combustion</td>
<td>--</td>
<td>0.4 - 1.0</td>
<td>ISO 9562: 1998, EN1485 - Determination of adsorbable organically bound halogens</td>
</tr>
<tr>
<td><strong>Tot P</strong></td>
<td>BS 6068: Section 2.28 1997, Determination of phosphorus – ammonium molybdate spectrometric method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tot N</strong></td>
<td>BS 6068: Section 2.62 1998, Determination of nitrogen Part 1 Method using oxidative digestion with peroxydisulphate, BS EN ISO 11905</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>pH</strong></td>
<td>SCA The measurement of electric conductivity and the determination of pH, ISBN 0117514284</td>
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</tr>
<tr>
<td><strong>Flow rate</strong></td>
<td>SCA Estimation of Flow and Load, ISBN 011752364X</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>SCA temperature measurement for Natural, Waste and Potable Waters and other items of interest in the Water and Sewage Disposal Industry ISBN 0117520179</td>
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<tr>
<td><strong>Fatty acids</strong></td>
<td>Determination of Volatile Fatty Acids in Sewage Sludge 1979, ISBN 0117514624</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td>BS 6068: Section 2.60 1998, Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chlorine</strong></td>
<td>BS6068: Section 2.27 1990, Method for the determination of total chlorine: iodometric titration method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trichloromethane (Chloroform)</strong> Bromoform</td>
<td>BS6068: Section 2.58, Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 10: Measurement methods for common substances to water

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Method</th>
<th>Detection limit</th>
<th>Valid for range</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispersants</td>
<td></td>
<td></td>
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<tr>
<td>Surfactants</td>
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</tr>
<tr>
<td>Anionic</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cationic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-ionic</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pentachlorophenol</td>
<td></td>
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<tr>
<td>Formaldehyde</td>
<td></td>
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<tr>
<td>Phosphates and</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>nitrates</td>
<td></td>
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<tr>
<td>Sulphites and</td>
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<td></td>
</tr>
<tr>
<td>sulphates</td>
<td></td>
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<td></td>
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<tr>
<td>Ammonia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grease and oils</td>
<td>IR absorption</td>
<td>0.06 mg/kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 11: Measurement methods for air emissions

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Method</th>
<th>Averaging time</th>
<th>Compliance criterion</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter</td>
<td>Isokinetic sample filtered and weighed</td>
<td>BS ISO 9096 suitable for 20 mg/m³ to 1000 mg/m³</td>
<td>BS ISO 9096: Stationary source emissions. Manual determination of mass concentration of particulate matter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Isokinetic sample filtered and weighed</td>
<td>BS EN 13284-1 suitable for around 5 mg/m³ and above</td>
<td>BS EN 13284-1 stationary source emissions. Determination of low range mass concentration of dust. Manual gravimetric method</td>
<td></td>
</tr>
<tr>
<td>Fluoride</td>
<td>gas sampled, isokinetically if droplets present, filtered and absorbed into NaOH, specific ion electrode</td>
<td>ISO DIS 15713 Stationary source emissions — Sampling and determination of gaseous fluoride content. Does not measure particulate fluoride. Is suitable for gas streams with droplets</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note about fluoride: Continuous instruments and other methods that measure gaseous fluoride only do not demonstrate compliance with emission limits for fluoride if particulate fluoride is present. However, particulate fluoride is usually below 10% of total fluoride emitted, and often considerably less than 10%. Consequently particulate emissions of fluoride can often be disregarded. Continuous instruments are particularly useful for investigating HF during process optimisation or process changes.

See also Monitoring Guidance (Ref 9).

Notes on measuring petroleum pitch fume.

The procedures specified in BS EN 9096 are not appropriate in every respect for monitoring the sticky aerosol which is typically emitted from petroleum pitch processes and which is difficult to measure.

The emissions of petroleum pitch fumes are a balance of vapour and particles, which is temperature dependent. As the temperature of the emissions falls, the balance between vapour and solid changes as more vapour condenses, particles form, grow larger and stick together.
Some modification of the sample collection methodology is therefore likely to be necessary. A study undertaken by TBV Science suggested that necessary modifications were:

- The filter or separating device should be close to the sampling nozzle to avoid the loss of sticky material in the section of the probe before the filter. Consideration should be given to the desirability of using an integrated filter and sampling nozzle. Such an arrangement will account for any losses before the filter, although the high tare weight of the unit may give rise to errors.

- For integrated units an alternative is to weigh the filter medium in the integrated unit and also clean out and measure the material deposited in the nozzle upstream of the filter.

- The filter should be able to capture aerosol at 0.3µm with 98% efficiency.

- When bitumen or tar fume is to be measured in the presence of mineral particulate matter, the petroleum pitch fume collected on the filter should be determined as cyclohexane-soluble material according to NIOSH method 5023 or HSE method MDHS 68. This will avoid over-estimation of emissions of petroleum pitch fume.

- Drying of filters for total particulate determination, and evaporation of solvent for cyclohexane-soluble material should be carried out at a temperature not exceeding 42°C to minimise loss of condensed volatile compounds.

For stack temperatures of 42°C or below, suitable equipment includes Gravimat and Zambelli, both have in-stack sampling heads close to the sampling nozzle and the filter is at stack temperature.

For stack temperatures over 42°C, the filtered material may evaporate and an alternative method is needed. In US EPA method 5A, the filter is outside the stack and is cooled to 42°C ±10°C. Material inside the probe liner has to be washed out and measured and this can lead to increased errors if adequate care is not taken.