

Process Guidance Note 3/4 (04)

Secretary of State's Guidance for Lead Glass, Glass Frit and Enamel Frit Manufacturing Processes



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1 Introduction

- 1.1 This note is issued by the Secretary of State, the Welsh Assembly Government (WAG) and the Scottish Ministers ("the Government") to give guidance on the conditions appropriate for the control of emissions into the air from lead glass, glass frit and enamel frit manufacturing processes/ installations¹. It supersedes guidance note PG3/4(95) published in August 1995.
- 1.2 This is one of a series of notes giving guidance on Best Available Techniques (BAT) and Best Available Techniques Not Entailing Excessive Cost (BATNEEC)². The notes are all aimed at providing a strong framework for consistent and transparent regulation of installations.
- 1.3 This note is for use under both Local Air Pollution Control (LAPC) established by Part I of the Environmental Protection Act 1990, and Local Air Pollution Prevention and Control (LAPPC) established by the Pollution Prevention and Control Act 1999³. It constitutes statutory guidance to regulators under regulation 37 of The Pollution Prevention and Control (England and Wales) Regulations 2000, SI 1973⁴. To the extent it provides guidance on techniques, it also constitutes statutory guidance to regulators under section 7(11) of the 1990 Act, and in any event regulators are expected to have regard to it. The note will be treated as one of the material considerations when determining any appeals made against a decision under either the 1990 or 1999 Acts.
- 1.4 The note also (where appropriate) gives details of any mandatory requirements affecting air emissions which are in force at the time of publication, such as those contained in Directions from the Government.
- 1.5 All processes are subject to BAT/ BATNEEC. In general terms, what is BAT/ BATNEEC for one process in a sector is likely to be BAT/ BATNEEC for a comparable process; but in each case it is, in practice, for regulators (subject to appeal) to decide what is BAT/ BATNEEC for the individual process and the regulator should take into account variable factors (such as configuration, size and other individual characteristics of the process) and the locality (such as proximity of particularly sensitive receptors⁵). Ultimately, therefore, what constitutes BAT/ BATNEEC is site specific but this guidance note comprises guidance for the generality of processes in the sector and careful regard should be had to it, in order to maximise consistency of permits as appropriate.

Site specific BAT/ BATNEEC

Who is affected

- 1.6 This guidance is for:
 - regulators: who must have regard to the guidance when determining applications and reviewing extant authorisations and permits
 - operators: who are best advised also to have regard to it when making applications, and in the subsequent operation of their process
 - members of the public: who may be interested to know what the Government considers (in accordance with the legislation) amounts to appropriate conditions for controlling air emissions for the generality of processes in this particular industry sector

1. The term "process(es)" is used in the remainder of the note to mean both "processes" under the Environmental Protection Act 1990 and "installations" under the Pollution Prevention and Control Act 1999.
2. BATNEEC is the formulation used in the Environmental Protection Act 1990 and BAT is used in the Pollution Prevention and Control Act 1999. For the purpose of this guidance note, the two concepts are regarded as having essentially the same effect.
3. In accordance the Pollution Prevention & Control (England and Wales) (Amendment) Regulations 2002, SI 2002/275, processes for lead glass, glass frit and enamel frit manufacturing transfer from regulation under the 1990 Act to the 1999 Act from 1 April 2005. The relevant date in Scotland under Part 2 of schedule 3 to SSI 2000/323 is 31 December 2002.
4. In Scotland section 24 of the Pollution Prevention and Control (Scotland) Regulations 2000.
5. Guidance on the relationship between BAT/BATNEEC and air quality objectives is contained in the General Guidance Manual on policy and procedures for A2 and B installations.

- 1.7 The guidance is based on the state of knowledge and understanding at the time of writing of:
- lead glass, glass frit and enamel frit manufacturing processes'
 - their potential impact on the environment and
 - what constitutes BAT/ BATNEEC for preventing and reducing air emissions
- 1.8 The note may be amended from time to time in order to keep abreast with developments in BAT/BATNEEC including improvements in techniques and new understanding of environmental impacts and risks. Such changes may be issued in a complete revision of this document, or in separate additional guidance notes which address specific issues. (It may not always be possible to issue amending guidance quickly enough to keep in absolute step with rapid changes, which is another circumstance where paragraph 1.5 above might apply.)
- 1.9 Steps will be taken to ensure that those who need to know about changes are informed. Operators (and their advisers) are, however, strongly advised to check with the regulator whether there have been any changes before relying on this note for the purposes of making an application under the 1990 or 1999 Acts or making any other decisions where BAT/ BATNEEC may be a consideration.

Consultation

- 1.10 This note has been produced in consultation with relevant trade bodies, representatives of regulators including members of the Industrial Pollution Liaison Committee, and other interested organisations.

Publication

- 1.11 This and the other published guidance in this series is available, free of charge, via Defra at www.defra.gov.uk. There are links to this site from the following web sites:
- Scottish Executive at www.scotland.gov.uk.
 - Environment Agency at www.environment-agency.gov.uk.
 - Scottish Environment Protection Agency at www.sepa.org.uk.

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- 1.12 General guidance explaining LAPPC and setting out the policy and procedures, is contained in the "General Guidance Manual on Policy and Procedures for A2 and B Installations" available from www.defra.gov.uk/environment/ppc/index.htm, 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. In Scotland there is the SEPA Practical Guide for Part B activities available from www.sepa.org.uk/ppc/guidance/practicalguidepartbactivities.pdf

- 1.13 In addition to the General Guidance Manual referred to above, explanation or clarification of certain terms used in this 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 LAPPC.

2 Timetable for compliance and reviews

Existing processes or activities

- 2.1 The previous guidance advised that upgrading to that standard should usually have been completed by 1 October 2001. Requirements still outstanding from any existing upgrading programme should be completed.
- 2.2 The new provisions of this note and the dates by which compliance with these provisions is expected are listed in the table below, together with the paragraph number where the provision is to be found. Compliance with the new provisions should normally be achieved by the dates shown. Authorisations/permits should be varied as necessary, having regard to the changes and the timetable.

Upgrading for this note

Table 1: Compliance timetable

Provision	Relevant paragraph / row in this note	Compliance date
Lead limit of 2 mg/m ³ from batch mixing and charging.	Table 2 Row 2	Within 12 months of the publication of this note.
Fluoride limit of 5 mg/m ³ from pot arch.	Table 2 Row 4	Within 12 months of the publication of this note.
Particulate limit of 10 mg/m ³ from batch mixing.	Table 2 Row 9	Within 12 months of the publication of this note.
Particulate limit of 20 mg/m ³ for all furnaces where the mass emission of particulate from any furnace exceeds 0.5kg in any one hour .	Table 2 Row 10	To be complied with as soon as practicable, which in most cases should be within 12 months of the publication of this note
All other provisions.	-	To be complied with as soon as practicable, which in most cases should be within 12 months of the publication of this note

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

Relaxation of conditions

- 2.4 Where provisions in the preceding guidance note have been deleted or relaxed, authorisations should be varied as necessary as soon as reasonably practicable. [Section 7](#) provides a summary of all changes.

New processes or activities

- 2.5 For new processes or activities, the authorisation/permit should have regard to the full standards of this guidance from the first day of operation.

Substantially changed processes or activities

- 2.6 For substantially changed processes or activities, the authorisation/permit should normally have regard to the full standards of this guidance with respect to the parts of the process that have been substantially changed and any part of the process affected by the change, from the first day of operation.

Permit reviews

Reviewing permits

- 2.7 Under LAPC the requirement is to review conditions in authorisations at least every four years. (Section 6(6) Environmental Protection Act 1990).
- 2.8 Under LAPPC the legislation requires permits to be reviewed periodically but does not specify a frequency. It is considered for this sector that a frequency of once every six years ought normally to be sufficient for the purposes of Regulation 15(1) Pollution Prevention and Control Regulations 2000.

More frequent review may be necessary in individual cases for the reasons given in Regulation 15(2). Further guidance on permit reviews is contained in chapter 26 of the General Guidance Manual. Regulators should use any opportunities to determine the variations to authorisations/permits necessitated by paragraph 2.2 above in conjunction with these reviews.

- 2.9 Under both LAPC and LAPPC, conditions should be reviewed where complaint is attributable to the operation of the process and is, in the opinion of the regulator, justified.

3 Process description

- 3.1 Lead glass, glass frit and enamel frit manufacturing processes are prescribed for:
- **LAPC**, under section 3.5 of Schedule 1 to the Environmental Protection (Prescribed Processes and Substances) Regulations 1991, SI 472 (as amended).
 - **LAPPC**, under section 3.3 Part B of Schedule 1 of the Pollution Prevention and Control (England and Wales) Regulations 2000 SI 1973. The dates on which existing LAPC part B prescribed processes transfer to LAPPC are set out in part 2 of schedule 3, which lists the prescribed dates for installations. Regulation 9 (1) requires that no person shall operate an installation after the prescribed date except under and to the extent authorised by a permit granted by the regulator. The date for section 3.3 Part B processes is 1 April 2005. (See Schedule 3 paragraph 9 (3) regarding applications being deemed to have been made for existing Part B processes).
 - Processes manufacturing glass frit or enamel frit, where the aggregate quantity of such substances manufactured in any period of 12 months is likely to be 100 tonnes or more, are subject to Integrated Pollution Prevention and Control, IPPC, for which separate guidance has been issued.
- 3.2 Separate notes have been produced which relate to other Part B prescribed glass processes. These are PG3/3(95) Glass (excluding lead glass) Manufacturing Processes, and PG3/6(95) Processes for the Polishing or Etching of Glass or Glass Products using Hydrofluoric acid.
- 3.3 Lead glass (glass using lead compounds in its manufacture) is used for glass tableware, decorations and specialist products. Production typically entails the following stages:
- raw materials, which may include lead oxide (red or white), silica sand, soda, potassium carbonate and aluminium hydroxide, are stored, weighed out and mixed to form furnace feed material known as batch. Recycled glass, known as cullet, is usually added to the mix; the batch is transferred to the melting furnaces as dictated by the melting process.
 - glass is produced, melted or refined in furnaces which will include the following:
 - (i) pot furnaces, or
 - (ii) day tanks, or
 - (iii) other furnaces or tanks.
 - furnaces may be electrically heated or fossil fuel fired, in the latter case recuperators or regenerators may be used to recover heat from exhaust gases.
 - production may be continuous or batch. Batch cycles vary up to 48 hours and include furnace pre-heating, batch material filling in one to three operations, ramping up to melting temperature, holding at high temperature (eg 1400°C) to refine the glass, and controlled cooling to the gathering temperature of around 1100°C. A typical furnace temperature profile is included in [Appendix 2](#) to illustrate the production cycle for a lead glass pot furnace which operates as a batch process on a 24 hour cycle. There are three main stages of the furnace production cycle, and emissions can vary considerably between these stages:
 - (i) The melt stage commences when the furnace temperature is increased prior to first fill, and is complete at takedown, when the refined glass starts to cool;
 - (ii) The cooling stage commences at takedown and finishes when the furnace reaches the operating or gathering temperature;
 - (iii) The glassmaking stage starts once the gathering temperature is reached and ends when the furnace temperature is increased at the beginning of the next production cycle.

- a gob of molten glass is gathered by hand or by machine or released by gravity from the tank through a heated bushing. The glass gob is formed into individual articles by hand or by machine.
- further processing includes annealing in hot ovens or lehrs, cutting and finishing.
- pot furnaces use clay pots which have a typical life of 12-13 weeks of normal operation. The pots may be delivered part fired to the site, and may undergo final firing either in a glass furnace or in a pot arch. The 'pot arching' process involves gradually ramping up the pot arch temperature over several days to around 1200°C. Operators should have regard to the standards of PG 3/2(95) "Manufacture of Heavy Clay Goods and Refractory Goods" when operating pot arches, although separate authorisation is not required provided that the pot arch is only used as part of the lead glass manufacturing process.

- 3.4 In the context of this note, frit is a glass which has been quenched and shattered. Glass frit is used as a raw material in the production of ceramic glaze, which may be clear or coloured. Similarly, enamel frit is a raw material in the production of enamel, used for stove enamelling, for example. Production takes place as follows:
- raw materials including, for example lead and cadmium oxides, china clay, borax, boric acid, silica and aluminium hydroxide are weighed and mixed.
 - the mixed materials are then transferred by feed pipe to a pre-heated frit kiln to produce molten glass. The kiln is fired typically by natural gas.
 - after a suitable residence time, the molten material is decanted from the furnace into a bath of cooling water to form globules of glass. This material is drained and may be stored or crushed to a smaller particle size.
 - subsequent operations may include mixing with minerals and pigments, and reheating in sintering kilns.

4 Potential releases

- 4.1 The key emissions from these processes that constitute pollution for the purposes of Part I of the Environmental Protection Act 1990 or the Pollution Prevention and Control Regulations 2000 and therefore warrant control are those consisting of particulate matter, lead and its compounds, fluorides, chlorides and products of combustion.
- 4.2 The following parts of the process may give rise to particulate matter and lead and its compounds:
- raw material storage and handling areas
 - batch mixing
 - glass melting furnaces. Emissions from batch production furnaces vary throughout the production cycle, typically peaking at batch fill operations during the melt stage (see [Appendix 2](#))
 - transfer of potentially dusty materials including discharge into hoppers and onto conveyors, and delivery to furnaces
 - glass cutting and processing
- 4.3 The following processes may give rise to oxides of nitrogen, oxides of sulphur:
- glass melting furnaces, annealing ovens, and other fossil fuel fired equipment.
- 4.4 The following parts of the process may give rise to other pollutants:
- the glass melting furnace releases fluorides, chlorides and metals, depending on raw material content
 - the Pot Arch may release fluorides when heating part-fired clay pots prior to a furnace pot change

5 Emission limits, monitoring and other provisions

- 5.1 The emission limit values and provisions described in this section are achievable using the best available techniques described in [Section 6](#). Monitoring of emissions should be carried out according to the method specified in this section or by an equivalent method agreed by the regulator. (See Ref. [\(e\)](#) (M1) and Ref. [\(f\)](#) (M2))
- 5.2 All emission limits relate to emissions from contained sources, including furnaces, unless specifically mentioned. Emission limits relate to individually measured samples, unless an averaging period is otherwise specified. Where a mass emission limit is used to derogate the emission concentration limit, annual monitoring should be carried out to demonstrate compliance.

The reference conditions for limits in Table 2 are as follows:

- ▶ All pollutant concentrations should be expressed at standard conditions of 273 K and 101.3 kPa measured dry.
- ▶ The concentrations of pollutants in furnace emissions should be normalised to 8% oxygen content measured dry for continuous furnaces and to 13% oxygen content measured dry for pot furnaces and other batch production furnaces, prior to take-down. Measurements of emission concentration and mass emission values for batch furnaces during the cooling stage should not be corrected for oxygen content after takedown has been initiated (see [Appendix 2](#) for terminology).
- ▶ Where oxygen is monitored continuously in-situ, a conversion to the measured dry basis should be permitted, using a factor agreed with the regulator, based on the water content of the waste gases calculated from the fuel composition.
- ▶ In situations where emission limits expressed in terms of concentrations of pollutants in the exhaust gases are not appropriate, emission limits may be expressed in terms of mass per unit of production. These circumstances are likely to arise where process changes are designed to reduce the waste gas volume and include, for example, the enrichment of combustion air with oxygen and electrical melting. The necessary conversion factor will vary according to the type of glass and furnace and should be determined for each process individually to give a mass emission limit which is no less stringent than the relevant concentration limit given in Table 2.

Table 2: Emission limits, monitoring and other provisions

Row	Substance	Source	Emission limits / provisions	Type of monitoring	Monitoring frequency (subject to paragraph 5.11)
1	Emissions of lead and its compounds calculated as the element.	For all furnaces where the mass emission of lead exceeds 25g in any one hour*.	5 mg/m ³ as averaged over the production cycle.	Furnaces for the manufacture of frit: test for each emission point specified by the regulator.	Annual.
				All other furnaces: tests at each emission point specified by the regulator.	6 monthly.
2	Emissions of lead and its compounds calculated as the element.	Extracted dust from batch mixing operations involving lead based compounds.	2 mg/m ³	Tests at each emission point specified by the regulator.	6 monthly.
3	Fluoride (expressed as hydrogen fluoride).	Where the mass emission of fluoride from any furnace exceeds 50g in any one hour period.	5 mg/m ³	Manual extractive testing.	Annual.
4	Fluoride (expressed as hydrogen fluoride).	Pot Arch.		Manual extractive testing or determination from clay analysis pre- and post-arching.	Annual.
5	Chloride (expressed as hydrogen chloride).	For all furnaces.	Emission concentration limit of 10 mg/m ³	Manual extractive testing.	Annual.
6	Cadmium and its salts.	For all frit manufacturing processes where the emission of the substance exceeds 1g in any one hour.	Emission concentration limit of 0.2 mg/m ³ (as the metal).	Manual extractive testing.	Annual.
7	Total arsenic, nickel, selenium, antimony, chromium and copper and their salts.	For all frit manufacturing processes where the aggregated emission of the substance exceeds 5g in any one hour	Emission concentration limit of 1 mg/m ³ (total of all metals).		Annual
8	Total manganese, vanadium and tin and their salts.	For all frit manufacturing processes where the aggregated emission of the substance exceeds 25g in any one hour.	Emission concentration limit of 5 mg/m ³ (total of all metals).		Annual
9	Particulates.	Dust extraction from batch mixing operations.	Emission concentration limit of 10 mg/m ³ .	Manual extractive testing.	Annual

Table 2: Emission limits, monitoring and other provisions

Row	Substance	Source	Emission limits / provisions	Type of monitoring	Monitoring frequency (subject to paragraph 5.11)
10	Particulates.	For all furnaces where the mass emission of particulate from any furnace exceeds 0.5 kg in any one hour.	Emission concentration limit of 20 mg/m ³ .	Manual extractive testing . Plus Continuous monitoring and recording .	Annual plus continuous.
11	Sulphur oxides (expressed as sulphur dioxide).	Where mass emission from any furnace exceeds 5 kg in any one hour.	Emission concentration limit of : 250 mg/m ³ for gas fired furnaces 750 mg/m ³ for oil fired furnaces.	Determination by fuel analysis on change of fuel. Plus manual extractive test	On change of fuel plus annual.
12	Nitrogen oxides.	For all furnaces where the emission of nitrogen oxides exceeds 5 kg in any one hour.	Emission concentration limit of 500 mg/m ³ .	Manual extractive test.	Annual.
13	Nitrogen oxides.	In the manufacture of special glass using nitrate in the batch.	Emission concentration limit of 2400 mg/m ³ .	Manual extractive test.	Annual.

* If in the view of the regulator there would be no significant difference in the level of environmental protection, then averaging the mass emission over the production cycle (for the purpose of calculating the threshold above which the emission limit for lead applies) may be acceptable in some circumstances, such as where lead is infrequently melted.

Monitoring, investigations and recording

5.3 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 will monitor emissions, make tests and inspections of the process and keep records, in particular:

- ▶ The operator should keep records of inspections, tests and monitoring, including all non-continuous monitoring, inspections and visual assessments. The records should be:
 - kept on site
 - kept by the operator for at least two years; and
 - made available for the regulator to examine

Information required by the regulator

5.4 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.

- ▶ The process operator should provide a list of key arrestment plant and should have a written procedure for dealing with its failure, in order to minimise any adverse effects.
- ▶ 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.
- ▶ The results of non-continuous emission testing should be forwarded to the regulator within 8 weeks of the completion of the sampling.

- ▶ Adverse results from **any** monitoring activity (both continuous and non-continuous) should be investigated by the operator as soon as the monitoring data has been obtained/received. The operator should:
 - identify the cause and take corrective action
 - record as much detail as possible regarding the cause and extent of the problem, and the action taken by the operator to rectify the situation
 - re-test to demonstrate compliance as soon as possible; and
 - notify the regulator

Visible emissions

- 5.5 Visible emissions should be limited and monitored as follows. Abnormal emissions require action as described in paragraph 5.6.
- ▶ 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.
 - ▶ All releases to air, other than condensed water vapour, should be free from persistent visible emissions.
 - ▶ All emissions to air should be free from droplets.
 - ▶ Visual assessments of emissions should be made frequently and at least once each day whilst the process is in operation. The time, location and result of these assessments should be recorded.

Abnormal events

- 5.6 The regulator needs to be notified about certain events, whether or not there is related monitoring showing an adverse result, and the operator should respond to problems which may have an adverse effect on emissions to air.
- ▶ In the case of abnormal emissions, malfunction or breakdown leading to abnormal emissions the operator should:
 - investigate and undertake remedial action **immediately**
 - adjust the process or activity to minimise those emissions; and
 - promptly record the events and actions taken
 - ▶ 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.

Continuous monitoring

- 5.7 Continuous **indicative** monitoring can be used as a management tool. In conjunction with continuous recording it identifies 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 when there is a sudden increase in emissions; for example if arrestment plant fails. For a given concentration of particulate, the output level varies with the instrument. It should be noted that not all monitors provide a linear response to an increase in particulate matter. The monitor should be set up to provide a baseline output when the plant is known to be operating under the best possible conditions; i.e. such that emissions are fully compliant with the authorisation/permit. The instrument manufacturer should be able to set an output level which corresponds to around 75% of the emission limit, to trigger alarms. Thus the alarms are activated in response to this significant increase in particulate loading above the baseline, so that warning of the changed state is given before an unacceptable emission occurs. The regulator may wish to agree the alarm trigger level.

- 5.8 All new continuous monitoring equipment should be designed for less than 5% downtime over any 3-month period. Where continuous monitoring is required, 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.
 - ▶ Purchasers of new or replacement monitoring equipment should specify the requirement for less than 5% downtime over any 3-month period, on ordering.
 - ▶ A summary of continuous emission monitoring results should be forwarded to the regulator at least once every six months. This information should include monthly averages, monthly maximum emission concentrations and that emission concentration exceeded for 5% of each day.

Calibration and compliance monitoring

- 5.9 Calibration of quantitative instruments and compliance monitoring should meet the following provisions as appropriate:
- ▶ 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 specified 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).
 - ▶ Non-continuous emissions monitoring of particulate matter should be carried out according to the main procedural requirements of BS ISO 9096: 2003, with averages taken over operating periods, excluding start-up and shutdown.
 - ▶ Operators should establish the typical composition, in particular fluoride content, of clay pots pre- and post-Arching.
- 5.10 Exhaust flow rates should be consistent with efficient capture of emissions, good operating practice and meeting the requirements of the legislation relating to the workplace environment.
- ▶ The introduction of dilution air to achieve emission concentration limits should not be permitted. Certain furnace designs may use dilution air to control flue temperatures; this is acceptable but the operator should provide documentary evidence from the furnace supplier or manufacturer.

Varying monitoring frequency

- 5.11 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", results from three or more monitoring exercises, carried out over a period of at least two years, or results from two or more monitoring exercises in one year supported by continuous monitoring should be used, and factors to consider include:
- any significant process changes in that time which might affect the monitored emission
 - 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 as they vary widely and are not consistent with each other
 - 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 as they are very close to the limit
- 5.12 The frequency of testing should be increased, for example, as part of the commissioning of new or substantially changed processes, or where emission levels are near to or approach the emission concentration limits.

Sampling provisions

- 5.13 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 13284-1 or 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.

6 Control techniques

Summary of best available techniques

6.1 The following table provides a summary of the best available techniques that can be used to control the process in order to meet the emission limits and provisions in [Section 5](#). Provided that it is demonstrated to the satisfaction of the regulator that an equivalent level of control will be achieved, then other techniques may be used.

Table 3: Summary of control techniques

Release source	Substance	Control technique
Material storage and handling.	Particulate matter.	<p>Containment.</p> <p>Pelletised batch material.</p> <p>Dust arrestment in mixing areas.</p> <ul style="list-style-type: none"> • bag filters • cartridge filters
Lead glass furnace flue gas.	Lead.	Minimise lead content of raw materials.
Furnace.	Particulate matter.	<p>For batch lead glass furnaces:</p> <p>Closed pot design.</p> <p>Use of furnace mouth stoppers.</p> <p>Procedures to control batch fill operation.</p> <p>Or:</p> <p>Open pot with abatement:</p> <ul style="list-style-type: none"> • bag filters or scrubbers <p>For continuous lead glass melting:</p> <p>Abate emissions</p> <ul style="list-style-type: none"> • bag filters or scrubbers
	Sulphur oxides.	Limit sulphur in fuel and raw material.
	Nitrogen oxides.	Low NOx burners. Control furnace temperature.
	Hydrogen chloride / fluoride.	Limit chloride and fluoride in raw materials, fuel and refractory materials.
	Metals and their salts.	Limit metals in raw materials, fuel and refractory materials.
Glass and enamel frit furnace flue gas.	Particulate matter and metals.	<p>Abatement</p> <ul style="list-style-type: none"> • wet scrubber

Techniques to control emissions from contained sources

Lead and particulate

- 6.2 Best available techniques are required to control lead emissions, for example from raw material delivery, storage, mixing, melting and other processing. All furnaces should be equipped with a temperature recorder and an audible high-temperature alarm.
- ▶ The handling and transfer of collected fine dusts from dry arrestment plant and from the storage of waste lead compounds should be carried out by methods which do not give rise to dust emission. Suitable practices include: (i) recycling within the process or (ii) discharging from the arrestment equipment directly into bags or drums in an enclosed filling booth extracted to a dust collector for subsequent disposal. Waste materials and packaging should be deposited in closed containers.
- 6.3 All sources of lead emissions should be addressed in order to meet the provisions of Section 5.
- ▶ All sources of lead emissions, such as mixing, charging points and dry glass cutting and processing should, where necessary, be hooded, adequately extracted to suitable arrestment equipment and vented to an adequately designed discharge point, as agreed with the regulator.

Oxides of sulphur

- 6.4 Practically all the sulphur in a fuel is emitted as sulphur oxides (SO_x). Limiting the sulphur in the fuel limits the emission of sulphur. The Acidification Strategy of the European Union has led to a Directive on sulphur content in certain liquid fuels. That Directive reduces the sulphur content of fuels meeting the definition of gas oil within the Directive to 0.2% from 1 July 2000 and to 0.1% by 1 January 2008. The sulphur content of gas oil, if used in the process, should be specified in the permit. The content should be confirmed by certificate from the supplier. Further on site testing of gas oil or heavy fuel oil is not normally required.

Techniques to control fugitive emissions

Dust, spillage and odour control

- 6.5 Fugitive emissions should be prevented wherever practicable. Material handling operations should be carried out so as to eliminate visible dust emissions.
- ▶ The receipt, handling and storage of liquid fuels should be carried out so as to minimise emissions to the air.
 - ▶ Bulk storage tanks should be fitted with a high level alarm or volume indicator to warn of, and thereby prevent, overfilling.
 - ▶ Above-ground bulk chemical and fuel storage tanks should be completely contained by bunding which is impervious and resistant to the fuel and chemicals in storage and capable of holding 110% of the capacity of the largest storage tank.
 - ▶ Dusty materials, such as lead compounds and crystalline silica, should be delivered to the process in a manner which prevents their escaping into the external environment. Use of enclosed containers or sealed bags, with the contents already oil dampened or wetted (normally up to 1% moisture), or the use of granular material are the preferred methods. Alternatively, for large quantities, delivery in an oil dampened or wetted condition (normally up to 1% moisture) in suitable bulk tankers, is acceptable. Where the material is to be sampled upon receipt, sampling should take place within an enclosed area, and preferably under cover.
 - ▶ The transport of dusty lead-bearing materials within the process should be carried out by methods which do not give rise to dust emissions. Preferred methods include pipeline, enclosed containers, or covered conveyors, or adequately covered vehicles.

- ▶ External above-ground conveyors for other dusty materials should be fitted with protection against wind whipping for example sideboards or totally enclosed. Transfer points- should be totally enclosed and ducted to suitable arrestment equipment such as fabric filters, as specified by the local enforcing authority in order to meet the emission limits above.
- ▶ Conveyor discharge points should be arranged to minimise at all times the free fall into store or receiving hopper. Care should be taken to ensure that the material is not dispersed around the site on the bodies of vehicles or on their wheels. Wherever appropriate, the materials should be suitably oil dampened or wetted.
- ▶ Stocks of dusty materials should be stored in purpose-built silos, enclosed store rooms or under cover so as to prevent wind whipping, and loading to and from stock piles should be carried out so as to minimise emissions to the air.
- ▶ Storage silos for dusty materials should be vented to air through suitable arrestment equipment, such as fabric filters, as specified by the local enforcing authority in order to meet the emission limit above.
- ▶ All floors and surfaces of storerooms, mixing rooms, charging points, and waste-holding areas should be kept clean at all times.
- ▶ All spillages should be cleared as soon as possible; solids by vacuum cleaning, wet methods, or other appropriate techniques. Dry sweeping of dusty spillages should not be permitted.
- ▶ A high standard of housekeeping should be maintained.

Air quality

Ambient air quality management

- 6.6 In areas where air quality standards or objectives are being breached or are in serious risk of breach and it is clear from the detailed review and assessment work under Local Air Quality Management that the Part B process itself is a significant contributor to the problem, it may be necessary to impose tighter emission limits. If the standard that is in danger of being exceeded is not an EC Directive requirement, then industry is not expected to go beyond BAT to meet it. Decisions should be taken in the context of a local authority's Local Air Quality Management action plan. For example, where a Part B process is only responsible to a very small extent for an air quality problem, the authority should not unduly penalise the operator of the process by requiring disproportionate emissions reductions. More guidance on this is provided in paragraph 360 of the Air Quality Strategy which gives the following advice:

“The approach from local authorities to tackling air quality should be an integrated one, involving all strands of local authority activity which impact on air quality and underpinned by a series of principles in which local authorities should aim to secure improvements in the most cost-effective manner, with regard to local environmental needs while avoiding unnecessary regulation. Their approach should seek an appropriate balance between controls on emissions from domestic, industrial and transport sources and draw on a combination and interaction of public, private and voluntary effort.”

Dispersion and dilution

- 6.7 Pollutants that are emitted via a stack require sufficient dispersion and dilution in the atmosphere to ensure that they ground at concentrations that are harmless. This is the basis upon which stack heights are calculated using HMIP Technical Guidance Note D1 (D1). 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 take into account the relevant air quality standards that apply for the emitted pollutants.

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 B process itself is a significant contributor to the problem.

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 impeding devices should not be used. A cone may sometimes be useful to increase the exit velocity and achieve greater dispersion.

An operator may choose to meet tighter emission limits in order to reduce the required stack height.

Stacks, vents and process exhausts

- 6.8 Liquid condensation on internal surfaces of stacks and exhaust ducts might lead to corrosion and ductwork failure or to droplet emission. Adequate insulation will minimise the cooling of waste gases and prevent liquid condensation by keeping the temperature of the exhaust gases above the dewpoint. Stacks and ductwork should be leakproof.
- 6.9 The dispersion from all stacks and vents can be impaired by low exit velocity at the point of discharge, or deflection of the discharge. Unacceptable emissions of droplets could possibly occur from wet arrestment plant where the linear velocity within the associated ductwork exceeds 9 m/sec. The use of mist eliminators reduces the potential for droplet emissions.
- ▶ Where a linear velocity of 9 m/sec is exceeded in the ductwork of existing wet arrestment plant, it should be reduced to the extent that is practicable to ensure that droplet fallout does not occur.
 - ▶ Flues and ductwork should be cleaned to prevent accumulation of materials, as part of the routine maintenance programme.
 - ▶ Exhaust gases discharged through a stack or vent should achieve an exit velocity which is normally greater than 15 m/sec during normal operating conditions to achieve adequate dispersion. A lower velocity may be acceptable provided it achieves adequate dispersion and dilution in accordance with paragraph 6.7 above.
 - ▶ Stacks or vents should not be fitted with any restriction at the final opening such as a plate, cap or cowl, with the exception of a cone which may be necessary to increase the exit velocity of the emissions.

Management

Management techniques

- 6.10 Important elements for effective control of emissions include:
- proper management, supervision and training for process operations;
 - proper use of equipment;
 - effective preventative maintenance on all plant and equipment concerned with the control of emissions to the air; and
 - it is good practice to ensure that spares and consumables are available at short notice in order to rectify breakdowns rapidly. This is important with respect to arrestment plant and other necessary environmental controls. It is useful to have an audited list of essential items.
- ▶ Spares and consumables - in particular, those subject to continual wear - should be held on site, or should be available at short notice from guaranteed local suppliers, so that plant breakdowns can be rectified rapidly.

Appropriate management systems

- 6.11 Effective management is central to environmental performance; It is an important component of BAT and of achieving compliance with permit conditions. It requires a commitment to establishing objectives, setting targets, measuring progress and revising the objectives according to results. This includes managing risks under normal operating conditions and in accidents and emergencies. It is therefore desirable that processes put in place some form of structured environmental management approach, whether by adopting published standards

(ISO 14001 or the EU Eco Management and Audit Scheme [EMAS]) or by setting up an environmental management system (EMS) tailored to the nature and size of the particular process. Operators may also find that an EMS will help identify business savings.

Regulators should use their discretion, in consultation with individual operators, in agreeing the appropriate level of environmental management. Simple systems which ensure that LAPC considerations are taken account of in the day-to-day running of a process may well suffice, especially for small and medium-sized enterprises. While authorities may wish to encourage wider adoption of EMS, it is outside the legal scope of an LAPC authorisation/LA-PPC permit to require an EMS for purposes other than LAPC/LA-PPC compliance. For further information/advice on EMS refer to EMS Additional Information in [Section 8](#).

Training

- 6.12 Staff at all levels need the necessary training and instruction in their duties relating to control of the process and emissions to air. In order to minimise risk of emissions, particular emphasis should be given to control procedures during start-up, shut down and abnormal conditions.

Training may often sensibly be addressed in the EMS referred to above.

- ▶ Training of all staff with responsibility for operating the process should include:
 - awareness of their responsibilities under the authorisation / permit; in particular, minimising fugitive emissions of lead through good operating practice;
 - minimising emissions on start up and shut down
 - action to minimise emissions during abnormal conditions
- ▶ The operator should maintain a statement of training requirements for each operational post and keep a record of the training received by each person whose actions may have an impact on the environment. These documents should be made available to the regulator on request.

Maintenance

- 6.13 Effective preventative maintenance should be employed on all aspects of the process including all plant, buildings and the equipment concerned with the control of emissions to air. In particular:
- ▶ A written maintenance programme should be provided to the regulator with respect to pollution control equipment; and
 - ▶ A record of such maintenance should be made available for inspection.

7 Summary of changes

Reasons for the main changes are summarised below.

Table 4: Summary of changes

Section/paragraph/row	Change	Reason	Comment
Emission limits, monitoring and other provisions			
Table 2, Row 2	Lead limit of 2 mg/m ³ from batch mixing and charging.	Limit readily achievable by e.g. pelletisation with bag filtration.	Previous limit was the same except in 'cases of difficulty' when it could be 5 mg/m ³ .
Table 2, Row 4	Fluoride limit of 5 mg/m ³ from pot arches.	Pot arches could be additional source of fluoride emission.	No mention of pot arch in previous PG note.
Table 2, Row 9	Particulate limit of 10 mg/m ³ from batch-mixing.	Limit readily achievable by BAT i.e. bag filters.	Limit was 50 mg/m ³ .
Table 2, Row 5	Chloride limit of 10 mg/m ³ .	BAT achieves well under 10 mg/m ³ .	Previous limit was 30 mg/m ³ .
Table 2, Row 10	Particulate limit of 20 mg/m ³ for all furnaces where the mass emission of particulate from any furnace exceeds 0.5kg in any one hour period.	Limit achieved by the use of closed pots, or open pots with abatement.	Previous limit was 100 mg/m ³ .
Table 2, Row 11 - 13	Nitrogen oxides and sulphur oxides reduced.	Industry already meets lower limits.	
5.2	Oxygen correction not required during post melt phase.	Oxygen levels can approach ambient and distort measurements.	
5.9	Use of BS 3405 for monitoring particulate matter emissions replaced by BS ISO 9096:2003. Sampling points on new plant should be designed to comply with BS ISO 9096:2003 requirements.	BS ISO 9096:2003 designed to measure concentrations below those for which BS3405 was written.	The main procedures of BS ISO 9096:2003 should be followed and any points of diversion from the standard noted. The effect on the results of any deviation from the standard should be estimated and reported.
Control techniques			
6.1 and Table 3	BAT is use of closed pots or open pots with abatement.	Needed to meet lead limit.	Already adopted by industry.
6.1 and Table 3	Scrubber plant for frit furnaces.	Needed to meet BAT.	

8 Definitions and further information

This guidance	Process Guidance Note 3/4 (04).
Previous guidance	Process Guidance Note 3/4 (95) which in its turn replaced 3/4 (91).
LAPC	explained in the Introduction of this guidance.
LAPPC	explained in the Introduction of this guidance.
Permit	the written permission to operate an installation prescribed for LAPPC – (the replacement for authorisation under LAPC).
Authorisation	the written authority to operate a process prescribed for LAPC - (will be replaced by permit under LAPPC).
Local enforcing authority	is replaced by the word 'regulator' in LAPPC.
Regulator	replaces the phrase 'local enforcing authority' from LAPC.
Existing process	should be taken to have the following meaning (which is based on paragraph 14 of Schedule 3 to SI 1991 /472): <ul style="list-style-type: none">• a process which was being carried on at some time in the 12 months immediately preceding the first day of the month following publication of this guidance note;• a process which is to be carried on at a works, plant or factory or by means of mobile plant which was under construction or in the course of manufacture or in the course of commission on the first day of the month following publication of this guidance note, or the construction or supply of which was the subject of a contract entered into before that date.
New process	not an existing process.
Authorised person	under section 108 of the Environment Act 1995, "authorised person" has replaced the term "inspector".
Installation	should be interpreted in accordance with the guidance contained in the the General Guidance Manual on Policy and Procedures for A2 and B Installations. www.defra.gov.uk/environment/ppc/manual/index.htm .
Process	the term "process has been used in this guidance note to refer to both "processes" under the Environmental Protection Act 1990 and "installations" under the Pollution Prevention and Control Act 1999.

Health and safety

Operators of processes and installations must protect people at work as well as the environment:

- requirements of a permit or authorisation should not put at risk the health, safety or welfare of people at work
- equally, the permit or authorisation must not contain conditions whose only purpose is to secure the health of people at work. That is the job of the health and safety enforcing authorities

Where emission limits quoted in this guidance conflict with health and safety limits, the tighter limit should prevail because:

- emission limits under the Environment Protection Act 1990 or Pollution Prevention and Control Act 1999 relate to the concentration of pollutant released into the air from prescribed activities
- exposure limits under health and safety legislation relate to the concentration of pollutant in the air breathed by workers
- these limits may differ since they are set according to different criteria. It will normally be quite appropriate to have different standards for the same pollutant, but in some cases they may be in conflict (for example, where air discharged from a process is breathed by workers). In such cases, the tighter limit should be applied to prevent a relaxation of control

EMS additional information

Further information/advice on EMS may be found from the following:

- Envirowise at www.envirowise.gov.uk and www.energy-efficiency.gov.uk and Environment and Energy Helpline freephone 0800 585794
- ISO 14001 www.bsi.org.uk or telephone BSI information centre (020 8966 7022)
- EU Eco Management and Audit Scheme (EMAS) www.emas.co.uk or telephone the Institute of Environmental Management and Assessment (01522 540069)

Regulators and process operators may also like to be aware of:

BS 8555: a new standard to help SMEs implement an EMS, by offering a five-phase approach, is contained in BS 8555 which was published in 2003 following on from work undertaken by the Acorn Trust. The Institute of Environmental Management and Assessment, which has taken over the Trust's activities, is developing a scheme of accredited recognition for companies achieving different phases of BS 8555. BS 8555 can be used to achieve ISO 14001 and registration to the higher standard, EMAS.

Some of the **High Street banks**, such as NatWest and the Coop, now offer preferential loan rates to organisations that can demonstrate they are committed to improving their environmental performance. The NatWest also produce a self help guide for SMEs, 'The Better Business Pack', focusing on waste, utilities, transport and supply chain issues. It gives tools, guidance and examples. Contact: WWF-UK on 01483 426444.

References

- (a) Secretary of State's Guidance (England and Wales): General Guidance Manual on Policy and Procedures for A2 and B Installations , March 2003 - available from the Defra website and, in hard copy, from the Defra Publications line 08459 556000 www.defra.gov.uk/environment/ppc/index.htm
- (b) DOE/WO Additional Guidance AQ17(94), issued to local authorities by the Air and Environment Quality Division of DEFRA and by the Welsh Office, provides further advice on the assessment of odour. The Scottish equivalent of AQ17(94) is SN 11(94).
- (c) Current air quality objectives are specified in:
 - The Air Quality (England) Regulations 2000 SI 928
 - The Air Quality (Wales) Regulations 2000 SI 1940
 - The Air Quality (Scotland) Regulations 2000 SI 97
- (d) HMIP Technical Guidance Note D1: "Guidelines on Discharge Stack Heights for Polluting Emissions", published by The Stationery Office, ISBN 0-11-752794-7.
- (e) M1 Sampling requirements for monitoring stack emissions to air from industrial installations, Environment Agency July 2002 ([EA website](#))
- (f) M2 Monitoring of stack emissions to air. Environment Agency May 2003 ([EA website](#))

Web addresses

The final consultation drafts and final published versions of all guidance notes in this series can be found on www.defra.gov.uk/environment/index.htm.

Welsh Assembly Government web-site www.wales.gov.uk.

Local Authority Unit of the Environment Agency for England and Wales. www.environment-agency.gov.uk.

Scottish Environment Protection Agency (SEPA) www.sepa.org.uk.

Energy saving and environmental management measures can increase industry profits. Envirowise (formerly ETBPP) show how at www.envirowise.gov.uk (or freephone 0800 585794).

Appendix 1: Extract from Pollution Prevention and Control (England and Wales)⁶ Regulations 2000 SI 1973⁷

(The processes for local air pollution prevention and control are listed under "Part B". The "Part A1" processes are for national regulatory control. The "Part A2" processes are subject to local authority integrated pollution prevention and control.)

Section 3.3 - Manufacturing Glass and Glass Fibre

Part A(1)

- (a) Manufacturing glass fibre.
- (b) Manufacturing glass frit or enamel frit and its use in any activity where that activity is related to its manufacture and the aggregate quantity of such substances manufactured in any period of 12 months is likely to be 100 tonnes or more.

Part A(2)

- (a) Manufacturing glass, unless falling within Part A(1) of this Section, where the melting capacity of the plant is more than 20 tonnes per day.

Part B

Unless falling within Part A(1) or A(2) of this Section -

- (a) Manufacturing glass at any location where the person concerned has the capacity to make 5,000 tonnes or more of glass in any period of 12 months, and any activity involving the use of glass which is carried out at any such location in conjunction with its manufacture.
- (b) Manufacturing glass where the use of lead or any lead compound is involved.
- (c) Manufacturing any glass product where lead or any lead compound has been used in the manufacture of the glass except -
 - (i) making products from lead glass blanks; or
 - (ii) melting, or mixing with another substance, glass manufactured elsewhere to produce articles such as ornaments or road paint.
- (d) Polishing or etching glass or glass products in the course of any manufacturing activity if -
 - (i) hydrofluoric acid is used; or
 - (ii) hydrogen fluoride may be released into the air.
- (e) Manufacturing glass frit or enamel frit and its use in any activity where that activity is related to its manufacture.

6. For activities carried out in Scotland the PPC (Scotland) Regulations should be referred to. For activities carried out in Ireland the PPC (Ireland) Regulations should be referred to.

7. Every effort has been taken to ensure that this Appendix is correct at the date of publication, but readers should note that the Regulations are likely to be subject to periodic amendment, and this Appendix should not therefore be relied upon as representing the up-to-date position after the publication date.

Appendix 2: Typical temperature profile for a pot melting lead glass

Figure 8.1: Furnace optical profile

