Sector Guidance Note

IPPC S3.03

Integrated Pollution Prevention and Control (IPPC)

Guidance for the Glass Manufacturing Sector (A1 processes)

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Executive summary

This guidance has been produced by the Environment Agency for England and Wales in collaboration with the Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment and Heritage Service (EHS). Together these are referred to as "the Regulator" throughout this document. Its publication follows consultation with industry, government departments and non-governmental organisations.

What is IPPC

Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. It involves determining the appropriate controls for industry to protect the environment through a single Permitting process. To gain a Permit, Operators will have to show that they have systematically developed proposals to apply the Best Available Techniques (BAT) and meet certain other requirements, taking account of relevant local factors.

The Regulators intend to implement IPPC to:

- protect the environment as a whole;
- promote the use of "clean technology" to minimise waste at source;
- encourage innovation, by leaving significant responsibility for developing satisfactory solutions to environmental issues with industrial Operators;
- provide a "one-stop shop" for administering applications for Permits to operate.

Once a Permit has been issued, other parts of IPPC come into play. These include compliance monitoring, periodic Permit reviews, variation of Permit conditions and transfers of Permits between Operators. IPPC also provides for the restoration of industrial sites when the permitted activities cease to operate.

This Guidance and the BREF

This UK Guidance for delivering the PPC (IPPC) Regulations in the Glass sector is based on the BAT Reference document BREF (see Reference 1) produced by the European Commission. The BREF is the result of an exchange of information between member states and industry. The quality, comprehensiveness and usefulness of the BREF is acknowledged. This guidance is designed to complement the BREF and is cross-referenced to it throughout. It takes into account the information contained in the BREF and lays down the standards and expectations in the UK (England and Wales, Scotland and Northern Ireland) for the techniques and standards that need to be addressed to satisfy the Regulations. The reader is advised to have access to the BREF.

The aims of this Guidance

The aims of this Guidance are to:

- provide a clear structure and methodology that Operators making an application should follow to ensure that all aspects of the PPC Regulations (see Appendix 2 for equivalent legislation in Scotland and Northern Ireland) and other relevant Regulations have been addressed (see Section 1.2), so it should assist the Operator to make a satisfactory application;
- minimise the effort by both Operator and regulator in the permitting of an installation by use of clear indicative standards and material from previous applications as well as from accredited Environmental Management Systems (EMSs);
- improve the consistency of applications by ensuring that all relevant issues are addressed;
- increase the transparency of the permitting process by having a structure in which the Operator's response to each issue, and any departures from the standards, can be seen clearly;
- improve consistency of regulation across installations and sectors by facilitating the comparison of applications;
- provide a summary of the BAT techniques for pollution control from the BREF and UK experience which are relevant in the UK context expressed, where possible, as clear indicative standards and which need to be addressed by Applicants;
- provide an arrangement of information which allows the reader to find, quickly all of the guidance associated with:
  - a subject (e.g. accidents, energy or noise) (Sections 2.1 and 2.5 - 2.11);
  - the technical areas (for example, melting techniques or effluent treatment) (Sections 2.3 - 2.4);
  - particular emissions (for example, NOx or pesticides) (Section 3).

To assist Operators in making applications, separate, horizontal guidance is available on a range of topics such as waste minimisation, monitoring, calculating stack heights and so on. Most of this guidance is available free through the Environment Agency, SEPA or EHS (Northern Ireland) websites (see References).

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1.1 Understanding IPPC and BAT

IPPC and the Regulations

Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. It involves determining the appropriate controls for industry to protect the environment through a single permitting process. To gain a Permit, Operators will have to show that they have systematically developed proposals to apply the Best Available Techniques (BAT) and meet certain other requirements, taking account of relevant local factors.

The essence of BAT is that the selection of techniques to protect the environment should achieve an appropriate balance between realising environmental benefits and the costs incurred by Operators.

IPPC operates under the Pollution Prevention and Control (England and Wales) Regulations, (see Reference 3 and Appendix 2). These Regulations have been made under the Pollution Prevention and Control (PPC) Act 1999 and implement the EC Directive 96/61 on IPPC. Further information on the overall system of IPPC, together with Government policy and more detailed advice on the interpretation of the Regulations, can be found in the Department of the Environment, Transport and the Regions (DETR) document *IPPC: A Practical Guide* (see Reference 4).

Installation-based, NOT national emission limits

The BAT approach of IPPC is different from regulatory approaches based on fixed national emission limits (except where General Binding Rules or standard permits are issued). The legal instrument which ultimately defines BAT is the Permit, and this can only be issued at the installation level.

Indicative BAT standards

Indicative BAT standards (essentially for BAT, but also covering other aspects) are laid out in national guidance (such as this) and should be applied unless there is strong justification for another course of action. It should be noted that BAT includes both the technical components of the installation given in Section 2 and the benchmark levels identified in Section 3. Departures from those standards, in either direction, can be justified at the local level taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. If there are any applicable mandatory EU emission limits, these must be met, although BAT may go further.

BAT and EQS

The BAT approach is also different from, but complementary to, regulatory approaches based on Environmental Quality Standards (EQS). Essentially, BAT requires measures to be taken to *prevent* or, where this is not practicable, to reduce emissions. That is, if emissions can be reduced further, or prevented altogether, at reasonable cost, then this should be done *irrespective* of whether any environmental quality standards are already being met. It requires us not to consider the environment as a recipient of pollutants and waste, which can be filled up to a given level, but to do all that is practicable to minimise the impact of industrial activities. The process considers what can be reasonably achieved within the installation first (covered by Sections 2 and 3 of this Guidance) and only then checks to ensure that the local environmental conditions are secure (Section 4 of this Guidance and Reference 6). The BAT approach is, in this respect, a more precautionary one, which may go beyond the requirements of Environmental Quality Standards.

Conversely, it is feasible that the application of BAT may lead to a situation in which an EQS is still threatened. The Regulations therefore allow for expenditure beyond BAT where necessary. However, this situation should arise very rarely assuming that the EQS is soundly based on an assessment of harm. The BAT assessment, which balances cost against benefit (or prevention of harm) should, in most cases, have come to the same conclusion about the expenditure which is appropriate to protect the environment.

Advice on the relationship of environmental quality standards and other standards and obligations is given in *IPPC: A Practical Guide* (see Reference 4) and in Section 3.

Assessing BAT at the sector level

The assessment of BAT takes place at a number of levels. At the European level, the EC issues a BAT reference document (BREF) for each sector. The BREF is the result of an exchange of information which member states should take into account when determining BAT, but which leaves flexibility to member states in its application. This UK Sector Guidance Note takes into account the information contained in the BREF and lays down the indicative standards and expectations in the UK. At this national level, techniques that are considered to be BAT should, first of all, represent an appropriate balance of costs and benefits for a typical, well-performing installation in that sector. Secondly, the techniques should normally be affordable without making the sector as a whole uncompetitive, either on a European basis or world-wide.

Assessing BAT at the installation level

When assessing which sectoral, indicative BAT standards at the installation level are applicable, departures may be justified in either direction as described above. The most appropriate technique may depend upon local factors and, where the answer is not self-evident, a local assessment of the costs and benefits of the available options may be needed. Individual company profitability is *not* considered. In summary, departures may be justified on the grounds of the technical characteristics of the installation concerned, its geographical location and the local environmental conditions but not on grounds of individual company profitability. Further information on this can be found in the *Guide for Applicants*, (see References 4 and 5).

Costs may only be taken into account at the local level:

- where the BAT cost/benefit balance of an improvement becomes favourable only when the relevant item of plant is due for renewal/renovation anyway (for example, BAT for the sector may be to change to a different design of furnace when one comes up for rebuild). In effect, these are cases where BAT for the sector can be expressed in terms of local investment cycles.
- where a number of expensive improvements are needed. Then a phasing programme may be appropriate as long as it is not so drawn out as to be seen as rewarding a poorly performing installation, (see Reference 6 for more details).

Innovation

The Regulators encourage the development and introduction of new and innovative techniques that meet the BAT criteria. They are looking for continuous improvement in the overall environmental performance of the process as a part of progressive sustainable development. This Sector Guidance Note describes the appropriate indicative standards at the time of writing. However, Operators should keep up-to-date with the relevant BATs. This note may not be cited in an attempt to delay the introduction of improved, available techniques. Furthermore, the technical characteristics of a particular installation may allow for opportunities not foreseen in the Guidance; as BAT is ultimately determined at the installation level, except in the case of General Binding Rules (GBRs), it is valid to consider these even where they go beyond the indicative standards.

New installations

The indicative requirements apply to both new and existing activities, but it will be more difficult to justify departures from them in the case of new installations. For new activities the indicative requirements should normally be in place before operations commence. In some cases, such as where the requirement is for an audit of ongoing operations this is not feasible and indicative upgrading timescales are given for such cases.

Existing installations-standards

For an existing activity, a less strict proposal (or an extended timescale) may be acceptable, for example, where the activity already operates to a standard that is very close to an indicative requirement (see Section 2 for further guidance). Equally, local environmental impacts may require action to be taken more quickly than the indicative timescales given in this Guidance. Furthermore, where IPC upgrading programmes are already in place, it is not expected that the indicative timescales given in this Guidance would extend to these.

All of the requirements identified in the BAT boxes in sections 2, 3 and 4 should be identified in the application (see also Note 1 in section 1.2). Where information is not available, the reason should be explained and discussed with the Regulator before finalising the application. The Regulator may require, by formal notice, information that is missing.

Existing installations-timescales

Upgrading timescales will be set in the improvement programme of the Permit, along the following lines. Improvements fall into a number of categories:

- the many good-practice requirements in Section 2, such as management systems, waste, water and energy audits, bunding, good housekeeping measures to prevent fugitive or accidental emissions, energy baseline measures, waste-handling facilities, monitoring equipment, installation of some secondary techniques or fitting abatement to smaller furnaces. Also, longer-term studies required for control, environmental impacts and the like – at the latest within 3 years of the issue of the permit;
- the larger, usually more capital-intensive improvements. For example, major changes of melting technology for large, continuous furnaces or complex secondary abatement measures that must be correctly sized – during furnace rebuild (may be 8 – 12 years for mineral wool, ceramic fibre or continuous filament glass fibre)

All improvements should be carried out at the earliest opportunity and to a programme approved by the Regulator. Any longer timescales will need to be justified by the Operator.

The Applicant should include a proposed timetable covering all improvements.

1.2 Making an application

Complete the separate APPLICATION FORM.

*The Application Form contains a number of questions about your **techniques**, **emissions** and **impact on the environment**. The sections in this Guidance Note are numbered to match the application form and describe in detail how to answer the questions.*

The *Guide for Applicants* (see Reference 5) will help filling in the form.

In SECTION 2, describe your proposals and justify that the TECHNIQUES employed are BAT by addressing the issues raised and the indicative standards in the outlined BAT boxes.

Departures may be justified as described in Section 1.1.

Indicative requirements (standards, benchmarks, improvement timescales etc.) are what the Regulator would expect for the majority of installations. If they apply to you, simply confirm compliance. There may, however, be good site-specific reasons for departure. You should justify any departures. See Section 1.1.

Assess further options

In SECTION 3, identify the EMISSION LEVELS that will result from the techniques described in Section 2 and compare with benchmarks (given in Section 3).

If the comparison is unsatisfactory (taking any site-specific matters into account) revisit the measures in Section 2 as necessary.

Justifications may vary from a simple statement to a full cost benefit analysis *(Note 1)*. **Where the costs and the cross-media benefits of different options need to be assessed the Assessment of BAT from Several Options part of Reference 6 will help you to do this.**

In SECTION 4, assess the ENVIRONMENTAL IMPACT and confirm acceptability

Assess that these overall emissions resulting from your view of BAT for the activities or installation will provide a high level of protection for the environment as a whole. The *Assessing Impact of the Installation* part of Reference 6 will help you to do this.

If the impact is not acceptable, it will be necessary to consider further options, revisiting the techniques in Section 2.

Note 1 The amount of detail needed to support the application should be sufficient to support the Applicant's contention that either the conditions of the guidance have been met or an alternative measure has been justified. The level of detail should be commensurate with the scale of the operation and its ability to cause pollution. An Applicant is not required to supply detail that could not reasonably be expected to contribute to a decision to issue a Permit.

Note 2 For existing IPC or Waste Management Permit holders, your response to each point in Sections 2, 3 or 4 may rely heavily on your previous application. The Regulator does not wish you to duplicate information as long as the previous information adequately addresses the issues. However, the more the information can be reorganised to demonstrate that all the issues have been adequately addressed the better. You will need to send us copies of any information referred to.

Note 3 To help Applicants, the contents of the outlined BAT boxes in Sections 2, 3 and 4, and additional blank tables and the like, are available electronically on the Environment Agency's Website.

1.3 Installations covered

This Note covers installations, described in Part A(1) of Schedule 1 to the PPC Regulations (see Reference 3 and Appendix 2) as follows.

3.3 Manufacturing glass and glass fibre:

a) Manufacturing glass fibre.

b) Manufacturing glass 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 twelve months is likely to be 100 tonnes or more.

3.5 Production of other mineral fibres:

a) Unless falling within Part A(1) or A(2) of section 3.3, melting mineral substances in plant with a melting capacity of more than 20 tonnes per day.

b) Unless falling within Part A(1) of section 3.3, producing any fibre from any mineral.

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

- storage and handling of raw materials;
- storage and despatch of finished products, waste and other materials;
- the control and abatement systems for emissions to all media;
- waste handling and recycling facilities.

At the time of writing this Note, processes operating in England and Wales that are covered under the above descriptions include the manufacture of:

- Continuous filament glass fibres;
- Mineral wool (glass wool and rock/slag wool);
- Ceramic fibre;
- Glass and enamel frits;
- Optical fibre.

Advice on the extent of the physical site which is contained within the installation, e.g. split sites, is given in *IPPC Part A(1) Installations: Guide for Applicants* (see Reference 5). Operators are advised to discuss this issue with the Regulator prior to preparing their application.

Where associated activities are carried out in conjunction with the main activities and are not covered in this guidance note (for example combustion activities), reference should be made to:

- other relevant IPPC Guidance Notes and,
- where appropriate, the Secretary of State's Guidance for Local Authority Air Pollution Control. (NB In Northern Ireland this guidance is produced by the Department of the Environment).

1.4 Review periods

Permits can be reviewed or varied at any time. However, the PPC Regulations impose a requirement on Regulators to review Permits in certain specific circumstances, such as where the pollution caused by the installation is of such significance that the existing emission-limit values need to be revised.

Regulators are also required to review the conditions of Permits "periodically". The Government stated in its third consultation paper (England, Wales and Scotland) on the implementation of IPPC, that the new sector-specific IPPC Sector Guidance Notes would suggest appropriate review periods for each sector. These would take into consideration guidance on the relevant criteria, to be provided by the Government. Examples of the likely relevant criteria for setting these review periods are "the risk and level of environmental impacts associated with the sector" and "the cost to the Regulators and regulated industry of undertaking the reviews".

The Regulators consider that, having regard to those criteria, it now appropriate to set indicative minimum review periods that differ only between those sectors which have been subject to integrated permitting (that is IPC or Waste Management Licensing) and those which have not. It is therefore proposed that Permit conditions should normally be reviewed on the following basis:

- for individual activities *not* previously subject to regulation under IPC or Waste Management Licensing, a review should normally be carried out within four years of the issue of the IPPC Permit;
- for individual activities previously subject to regulation under IPC or Waste Management Licensing, a review should normally be carried out within six years of the issue of the IPPC Permit.

So activities/installations not currently in IPC or Waste Management Licensing will be initially reviewed within four years and thereafter within six years.

An exception to this is where discharges of List I or List II substances have been permitted, or where disposal or tipping for the purposes of disposal, of any matter that might lead to an indirect discharge of any substance on List I or II. In such cases the review must be carried out within four years.

This period will be kept under review and, if any of the above factors change significantly, may be shortened or extended.

1.5 Key issues for each sector

Dust

All of the sectors within the glass industry involve the use of powdered, granular or dusty raw materials. The storage and handling of these materials represents a significant potential for dust emissions.

Releases associated with energy use

Glass making is a high temperature, energy intensive activity, resulting in the emission of products of combustion and the high temperature oxidation of atmospheric Nitrogen, i.e. SO_2, CO_2, NOx.

Emissions to air from melting operations

Furnace emissions also contain dust, which arises mainly from the volatilisation and subsequent condensation of volatile batch materials.

Furnace re-builds/modifications

Many of the sectors within the glass industry utilise large continuous furnaces with lifetimes of up to twelve years. During a campaign, opportunities to modify the furnace can be limited. Burner modifications or replacement can be relatively straightforward. Major changes affecting melting technology are usually most economically implemented if coinciding with furnace re-builds. This can also be true for complex secondary abatement measures. For smaller furnaces with more frequent re-builds the advantages of co-ordinating environmental improvements and furnace repairs are less significant.

1.6 Summary of releases for each sector

1.6.1 Continuous filament glass fibre
(see note 1)

SOURCE → / RELEASES ↓	Raw materials handling	Melting	Fiberising (forming)	Coating	Curing	Cooling	Trimming/packaging	Miscellaneous secondary processing	Binder wastes	Waste water (note 2)
Particulate (note 3)	A	A								
Waste fibre (note 4)			L				L	L		
CO_2	A (note 7)	A								
NOx		A								
SOx		A								
Fluorides (HF)		A								
Chlorides (HCl)		A								
VOC (note 5)		A	A	A				A		
Metals		A (note 8)								
Water vapour	A (note 7)	A			A					
Phenol	A	A								
Formaldehyde	A	A								
Ammonia	A	A								
Amines	A	A								
COD	W		W					W		W
Binder wastes (note 6)				L						
KEY	A – Release to Air, W – Release to Water, L – Release to Land									

Notes:

1. Based on a cross-fired fossil fuel (or oxy-fuel fired) recuperative furnace.
2. Water wastes can be derived from forming area, binder preparation/application, cleaning, cooling and water based scrubbers. The wastewater pollutant concentrations are usually very low (less than 0.2% solid concentration before treatment), due to the dilution by wash down water, and their content I mostly biodegradable. The chemicals used do not contain any heavy metals, or dangerous listed substances, but the actual composition varies widely from site to site, due to the great variety of binder compositions. For some products, a chrome based coupling agent is still used, but this is being gradually phased out.
3. Dust collected in abatement equipment can be recycled to the furnace.
4. Consists of up to 25% water and dilute binder.
5. The term Volatile Organic Compounds (VOC) includes all organic compounds released to air in the gas phase.
6. As dry solids.
7. From raw materials decomposition.
8. Heavy metals include V, Ni, Cr, Se, Pb, Co, Sb, As, Cd.

1.6.2 Mineral wool (glass wool and stone wool)

SOURCE → / RELEASES ↓	Raw materials handling	Melting (coke fired cupola) (note 2)	Melting (gas fired)	Melting (electric)	Melting (fossil fuel/electric)	Fiberising and forming	Curing	Cooling	Finishing (cutting/handling/packaging)	Waste water
Particulate	AL (note 1)	AL (note 3)	AL (note 3)	AL (note 3)	AL (note 3)	A	A	A	AL	
NOx		A	A	A	A		A			
SOx		A	A		A					
Chlorides (HCl)		A	A	A	A					
Fluorides (HF)		A	A	A	A					
Metals		A								
CO_2		A	A	A	A		A			
CO		A		A (note 4)						
H_2S		A		A (note 4)						
VOC (note 5)						A	A	A		
Phenol						A	A	A		
Formaldehyde						A	A	A		
Ammonia						A	A	A		W
Amines						A	A	A		
Water vapour							A			
Odour							A			
COD	W									W
KEY	A – Release to Air, W – Release to Water, L – Release to Land									

Notes: 1 Includes raw material spillages.

2 Operates under strong reducing conditions where NOx levels will be low, part of the S is released from fuel or raw materials, CO levels are high.

3 Includes dust collected from abatement equipment where not recycled into furnace.

4 Immersed electric arc stone furnace.

5 The term Volatile Organic Compounds (VOC) includes all organic compounds released to air in the gas phase.

1.6.3 Ceramic fibre

SOURCE → / RELEASES ↓	Raw materials handling	Melting (electric) (note 1)	Fiberising	Curing	Needling	Lubricant burn off	Slitting/trimming/cutting/packaging	Secondary processing	Waste water (note 2)
Particulate (note 3)	AL	AL	AL		AL	AL	AL		W
Ceramic fibre			AL		AL	AL	AL	A	
VOC (note 4)								A	
NOx		A							
Fluorides (HF)		A							
Chlorides (HCl)		A							
Oil									W
Water treatment chemicals									W
Organic substances									W
Dissolved salts									W
KEY	A – Release to Air, W – Release to Water, L – Release to Land								

Notes:

1. Waste gas volumes from electric melters are very low.
2. The main uses of water in this sector are cleaning, cooling and for vacuum forming and other secondary processing. The aqueous emissions are limited to the cooling water system purges, cleaning waters and surface water run off. The cleaning waters do not present any particular issues that would not be common with any industrial facility, that is inert solids and oil. Cooling system purges will contain dissolved salts and water treatment chemicals. Surface water quality will depend on the degree of drainage segregation and site cleanliness. Water used for vacuum forming is recycled with a purge, which may contain low levels or organic substances.
3. Waste collected from dust abatement systems is not generally recycled to the furnace.
4. The term Volatile Organic Compounds (VOC) includes all organic compounds released to air in the gas phase.

1.6.4 Frits (glass and enamel)
(see note 1)

SOURCE → / RELEASES ↓	Raw materials handling	Charging	Melting	Quenching	Drying	Bagging	Milling (dry)	Abatement plant	Waste water (cooling/cleaning/surface run off)
Particulate	A	A	A	W	A	A	A		WL (note 2)
Heavy metals (note 3)	A	A	A	W	A				WL (note 2)
NOx			A		A				
SOx			A						
Chlorides (HCl)			A						
Fluorides (HF) (note 4)			A						
Solid Waste-	L		L					L	
KEY	A – Release to Air, W – Release to Water, L – Release to Land								

Notes: 1 Furnaces are generally fossil fuel fired (mainly natural gas, or oxy-gas, and some fuel oil).

2 Solids are separated from the waste stream, not usually recycled into the process.

3 Heavy metals include: V, Ni, Cr, Se, Pb, Co, Sb, As, Cd. Note that cadmium may be present if it is used in the batch materials. The presence of metals will depend on the precise frit formulation being manufactured. The metals may be present in particulate matter.

4 Generally only applicable to enamel frit plants.

1.6.5 Optical fibre

SOURCE → / RELEASES ↓	Vapour deposition	Annealing	Draining	Waste water	
Particulate	A			W	
Hydrogen fluoride (HF)	A				
Hydrogen Chloride (HCl)	A	A			
Chlorine	A	A			
VOC (note 1)			A		
COD				W	
KEY	A – Release to Air, W – Release to Water, L – Release to Land				

Notes: 1 The term Volatile Organic Compounds (VOC) includes all organic compounds released to air in the gas phase.

1.7 Overview of the activities in this sector

Type of operation	Approximate number of installations in the UK Source: BREF	Approximate number of furnaces Source: BREF & Environment Agency public registers
Continuous filament glass fibre	2	4
Mineral wool (glass and rock)	6	11
Ceramic fibre	2	2
Frit (enamel and glass)	4	24
Optical fibre	4	4

Summary of the activities

This section gives a very brief overview of the Glass Industry as a whole and summarises the main activities of the processes specifically covered by this guidance note. More detail can be found in the BREF document.

The Glass Industry within the EU is extremely diverse, both in the products made and the manufacturing techniques employed. Techniques vary from small electrically heated furnaces in the Ceramic Fibre sector to the cross-fired regenerative furnaces found in the Flat Glass sector (not covered by this note).

The major environmental challenges for the Glass Industry are emissions to air and energy consumption. Glass making is a high temperature, energy intensive activity, resulting in the emission of products of combustion and the high temperature oxidation of atmospheric nitrogen; that is, sulphur dioxide, carbon dioxide, and oxides of nitrogen. Furnace emissions also contain dust, which arises mainly from the volatilisation and subsequent condensation of volatile batch materials. The very finely divided particulate associated with the emissions for this sector have the potential to give rise to very visible plumes. Emissions to the water environment are relatively low and there are few major issues that are specific to the Glass Industry. An exception to this is the continuous filament glass fibre sector. Solid waste levels are also generally very low, and many initiatives have been implemented for reducing waste generation, and for recycling in-house and post consumer waste.

1.7.1 Melting techniques

BREF sections 2.3, 4.2, 4.4.2.3, 4.4.2.5

The choice of melting technique will depend on many factors but particularly the required capacity, the glass formulation, fuel prices, existing infrastructure and environmental performance. Glass furnaces are generally designed to melt large quantities of glass over a continuous period of up to twelve years and range in output from 20 tonnes of glass per day to over 600 tonnes of glass per day. There are many furnace designs in use, and they are usually distinguished in terms of the method of heating, the combustion air preheating system employed, and the burner positioning. Brief descriptions of furnace types are give here. For more detail refer to the BREF.

Where possible, continuous melt techniques should be favoured in preference to batch techniques. Continuous melt techniques should be more energy efficient as batch techniques will involve comparatively frequent, and energy intensive, start up and shut down events. Also, continuous melting techniques are likely to result in emissions being of a more consistent nature whereas batch melting will involve peak emissions being generated during the period after charging until melting is complete and much lower emissions thereafter. However, it is recognised that smaller processes with many different formulations cannot practically operate on a continuous basis.

Regenerative furnaces: Burners firing fossil fuels are usually positioned in or below combustion air/waste gas ports. The heat in the waste gases is used to preheat air prior to combustion. The furnace fires on only one of two sets of burners at any one time. After a predetermined period, usually twenty minutes, the firing cycle of the furnace is reversed and the combustion air is passed through the chamber previously heated by the waste gases. A regenerative furnace has two regenerator chambers, while one chamber is being heated by waste gas from the combustion process, the other is preheating incoming combustion air. Preheat temperatures up to 1400 °C may be attained leading to very high thermal efficiencies. Furnaces may be end- or cross-fired (see BREF section 2.3). End-fired furnaces tend to be more cost effective; cross-fired designs better for larger furnaces.

Recuperative furnaces: Usually used for smaller furnaces. The incoming cold air is pre-heated indirectly by a continuous flow of waste gas through a metal (or, exceptionally, ceramic) heat exchanger. Air preheat temperatures are limited to around 800 °C for metallic recuperators, and the heat recovered by this system is thus lower than for the regenerative furnace. This may be compensated by additional heat recovery systems on the waste gases, either to preheat raw materials or for the production of steam. The specific melting capacity of recuperative furnaces is limited to 2 tonnes/m^2/day compared to typically 3.2 tonnes/m^2/day for a regenerative furnace (Container Glass). This lack of melting capacity can be partially compensated by the use of electric boosting.

All unit melters (direct-fired) furnaces are now equipped with recuperators. The burners are located along each side of the furnace, transverse to the flow of glass, and fire continuously from both sides. This allows better control and more stable temperatures than in end-fired furnaces. This type of furnace is primarily used where high flexibility of operation is required with minimum initial capital outlay, particularly where the scale of operation is too small to make the use of regenerators economically viable.

Oxy-fuel melting: that is the replacement of the combustion air with oxygen (>90 % purity). Eliminating the majority of the nitrogen from the combustion atmosphere reduces the volume of the waste gases, which are composed almost entirely of carbon dioxide and water vapour, by about two thirds. Energy savings are possible and the formation of thermal NOx is greatly reduced. In general oxy-fuel furnaces have the same basic design as unit melters, with multiple lateral burners and a single waste gas exhaust port. However, furnaces designed for oxygen combustion do not utilise heat recovery systems to pre-heat the oxygen supply to the burners. The principle of oxy-fuel furnaces is well established, particularly in the frits sector.

Electric melting: An electric furnace consists of a refractory lined box supported by a steel frame, with electrodes inserted either from the side, the top or, more usually, the bottom of the furnace. The energy for melting is provided by resistive heating as the current passes through the molten glass. Fossil fuels are required when the furnace is started up at the beginning of each campaign. The furnace is operated continuously and has a lifetime of between 2 and 7 years. The top of the molten glass is covered by a layer of batch material, which gradually melts from the bottom upwards, hence the term cold top melter. Fresh batch material is added to the top of the furnace, usually by a conveyor system that moves across the whole surface. Most electric furnaces are fitted with bag filter systems and the collected material is recycled to the melter. The technique is commonly applied in small furnaces.

The absence of combustion in electric melting means that the waste gas volumes are extremely low, resulting in low particulate carry over and reduced size of any secondary abatement equipment. The emission of volatile batch components is considerably lower than in conventional furnaces due to the reduced gas flow and the absorption and reaction of gaseous emissions in the batch blanket. The main gaseous emission is CO_2 from the carbonaceous batch materials.

Sodium or potassium nitrate is used in the batch in cold-top electric furnaces to provide the necessary oxidising conditions for a stable, safe and efficient manufacturing process. The nitrate then breaks down in the furnace to release NOx.

Combined fossil fuel and electric melting: This can be either fossil fuel firing with electric boost; or predominantly electrical heating with a fossil fuel support. Electric boosting adds extra heat to a glass furnace by passing an electric current through electrodes in the bottom of the tank and is commonly used within fossil fuel fired furnaces. The technique can be installed while a furnace is running, and it is often used to support the pull rate of a furnace as it nears the end of its operating life or to increase the capacity of an existing furnace. Electric boosting can also be used to improve the environmental performance of the furnace by substituting electrical heating for combustion for a given glass pull rate. A high level of electric boost is not used as a long-term option for base level production due to the associated high operating costs.

Gas or oil can be used as a support fuel for a principally electrically heated furnace. This simply involves firing flames over the surface of the batch material to add heat to the materials and aid melting, sometimes referred to as over-firing.

Special melter designs:

The ***Sorg LoNOx melter*** uses a combination of shallow bath refining and raw material preheating to achieve reduced NOx levels, potentially without the penalty of reduced thermal performance. The furnace can be operated at lower temperatures than a comparable conventional furnace.

The ***Sorg Flex Melter***, is principally marketed as an alternative to pot furnaces and day tanks. It uses a combination of electricity and natural gas resulting in a compact furnace with low operating temperatures and low energy consumption. The furnace is divided into melting and refining zones, which are connected by a throat. The melting end is electrically heated and the refining zone is gas heated, but electrodes may be added at the entrance. The waste gases from the refining zone pass through the melting area and over the batch. During standstill periods temperatures are lowered and volatilisation from refining is reduced. No drain is needed and due to the low glass volume, normal operating temperature is re-established quickly. The low volume also helps to make faster composition changes.

The ***FENIX process*** combines a number of primary measures for the optimisation of combustion and the reduction of energy consumption. The combustion system has been completely modified and new types of injectors are used. It is not yet a commonly used technique.

1.7.2 Continuous filament glass fibre

The glass melt for continuous filament glass fibre is predominantly produced in natural gas fired recuperative furnaces with the facility for electric boost (some are oil fired). There are also a number of oxy-fuel fired furnaces in Europe, but these have only been operating for a limited period. The most commonly used glass formulation in this sector is E Glass, which has a very low alkali content resulting in low electrical conductivity. It is not currently considered economically viable to melt E Glass using 100% electric melting.

The molten glass flows from the front end of the furnace through a series of refractory lined, gas heated canals to the forehearths. In the base of each forehearth there are bushings to allow flow of glass. The bushing is electrically heated and its temperature is precisely regulated over the whole surface in order to obtain a consistent flow rate of molten glass from each hole.

The glass flowing through the bushing tips is drawn out and attenuated by the action of a high-speed winding device to form continuous filaments. Specific filament diameters in the range of 5µm to 24µm are obtained by precisely regulating the linear drawing speed (which may vary from 5 m/s to 70 m/s). Directly under the bushing, the glass filaments undergo a drastic cooling.

The filaments are drawn together and pass over a roller or belt, which applies an aqueous mixture, mainly of polymer emulsion or solution to each filament. The binder content on the filaments is typically in the range of 0.5% to 1.5% by weight. The coating material will vary depending on the end use of the product.

The coated filaments are gathered together into bundles called strands that go through further processing steps, depending on the type of reinforcement being made. The strands can undergo either conventional or direct processing. In conventional processing, the strands are wound onto the rotating mandrel of the winder to form “cakes” up to 50 kg in weight. For some applications the cakes can be processed wet, but for most they have to pass through drying ovens. The ovens are heated by gas, steam, electricity, or indirectly by hot air. The main products are chopped strands, rovings, chopped strand mats, yarns, tissues, and milled fibres as shown in Figure 1.

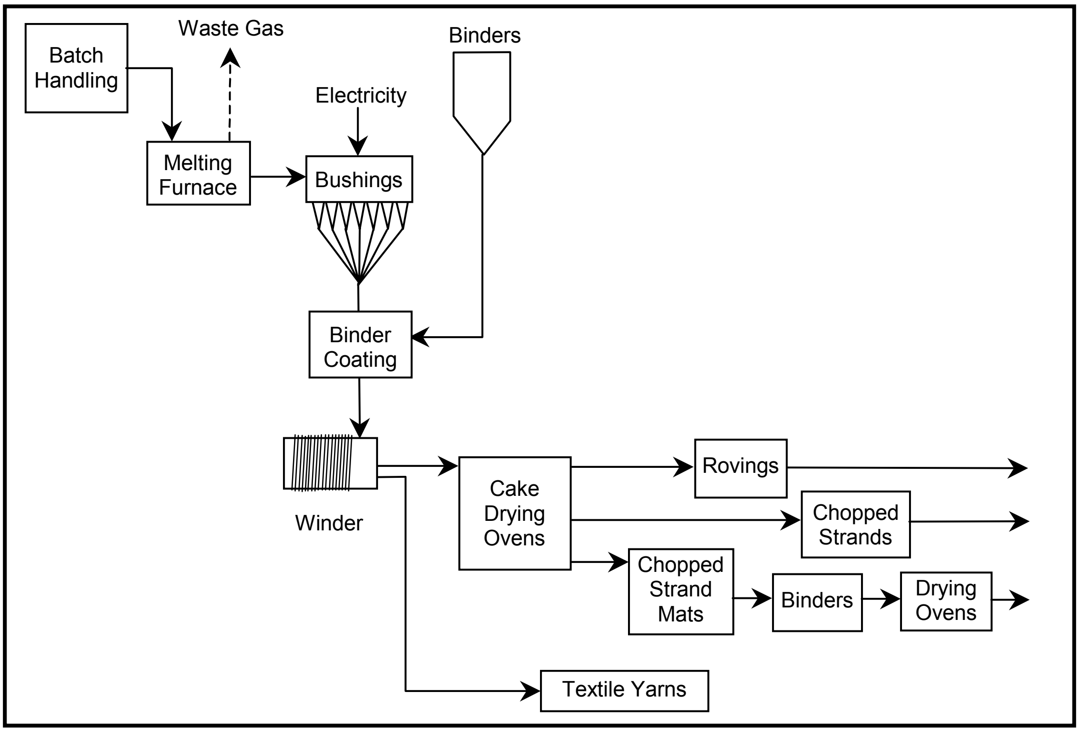

Figure 1: Generalised continuous glass filament manufacturing process

- ***Chopped strands*** are produced by unwinding the cakes and feeding the filaments into a machine with a rotating bladed cylinder. The chopped strands are typically between 3 mm and 25 mm, and are conveyed into a variety of packages up to 1 tonne in weight.
- ***Rovings*** are produced by unwinding and combining the strands from multiple cakes, sufficient to achieve the desired weight of glass per unit length
- ***Chopped strand mat*** is produced by chopping the strands unwinding from cakes, or rovings, in cylindrical choppers. The choppers are arranged so that chopped strands can be applied to a moving conveyor belt up to 3.5 m wide. The strands are sprayed with a secondary binder, for example, an aqueous solution of polyvinyl acetate or saturated polyester powder. The conveyor takes the now wet mat through a drying and curing oven, and then through a pair of compaction rollers before winding the mat onto a mandrel.
- ***Yarn products*** are produced from either dried forming cakes or from wet cakes, where the drying of the strands takes place during the twisting operation. The yarn is made on a twisting machine (or twist frame) which holds up to 100 cakes, containing any combination of different strands. The strands are brought together, twisted into a yarn and wound onto a bobbin.
- ***Glass fibre tissue*** is produced by chopping the strands unwound from the cakes in cylindrical choppers, which feed either directly into a pulper or into intermediate bulk containers for later use. After dispersion in the pulper, the fibres are applied to a wire mesh conveyer belt by the wet-laid method. An aqueous solution of different types of resins, polyvinyl alcohol and latex is added as a binder at up to 20% (dry content). The wire takes the web through a drying and curing oven before winding the tissue onto a tambour. The glass fibre tissue can be made in various densities and widths.
- ***Milled fibres*** are made by milling cakes or chopped strands into lengths of 50 - 300 µm. The milled fibres are conveyed into a variety of packages from 20 kg up to 1 tonne.

Chopped strands, rovings, and continuous filament mats can also be produced by direct processes. Chopped strands are produced by directly introducing the strand, following coating, into a high-speed chopper. The strands are collected and, depending on the product use, either packaged wet or are dried. Direct rovings are produced using a bushing plate with a particular number of holes of different diameters, corresponding to the desired product. The filaments can be coated and the roving dried in the normal way. Continuous filament mat is produced by directly laying the strands onto a moving conveyor and spraying with an aqueous or powder binder. A special device is used to ensure correct deposition of the filaments on the conveyor. The mat passes through a drying oven and compaction rollers, before being wound onto a mandrel and packed.

1.7.3 Mineral wool

Mineral wool manufacture consists of the following stages: raw material preparation; melting; fiberisation of the melt; binder application; product mat formation; curing; cooling; and product finishing. Mineral wool can be divided into two main categories: glass wool; and stone or slag wool. The products are used in the essentially same applications and differ mainly in the raw materials and melting methods. Following the melting stage the processes and environmental issues are essentially identical.

1.7.3.1 Glass wool

The raw materials for glass wool manufacture are mainly delivered by road tanker and pneumatically conveyed into storage hoppers. Each process will use a range of raw materials and the precise formulation of the batch may vary considerably between processes. The basic materials for glass wool manufacture include sand, soda ash, dolomite, limestone, sodium sulphate, sodium nitrate, and minerals containing boron and alumina.

Most processes also use process cullet as a raw material. Process cullet has the same precise formulation as the final product, and is readily recycled to the furnace. Other forms of waste glass, for example, bottle cullet and plate glass cullet are also increasingly used as a feedstock. This type of material is more difficult to recycle and its use depends heavily on cost, composition, purity and consistency of supply.

Several manufacturers also recycle processed fibrous waste and the dust collected from the furnace waste gas stream to the melter. The fibrous nature of much of the waste makes it impracticable to recycle without further treatment. Glass furnace raw materials are charged as powders or in granular form, and so waste material must be ground or pelletised before charging. This is usually achieved by some form of milling operation. The waste product and the filtered waste contain significant levels of organic binder. In a glass furnace the carbon content of the waste presents a number of potential problems including: reduced heat transfer; foaming; destabilisation of melting conditions; and alteration of the furnace chemistry. These problems can be mitigated but there is a limit to the amount of waste that can be recycled to the furnace. Furthermore, it can be necessary to add sodium or potassium nitrate as an oxidising agent, and the decomposition of these materials can add significantly to the emissions of oxides of nitrogen.

The various raw materials are automatically weighed out and blended to produce a precisely formulated batch. The blended batch is then transferred to an intermediate storage hopper before it is added to the furnace.

The furnace (with a few rare exceptions) will either be an electrically heated furnace, a traditional gas fired recuperative furnace, or less commonly an oxy-gas furnace.

A stream of molten glass flows from the furnace along a heated refractory lined forehearth and pours through a number (usually one to ten) of single orifice bushings into specially designed rotary centrifugal spinners. Primary fiberising is by centrifugal action of the rotating spinner with further attenuation by hot flame gases from a circular burner. This forms a veil of fibres with a range of lengths and diameters randomly interlaced. The veil passes through a ring of binder sprays that spray a solution of phenolic resin based binder and mineral oil onto the fibres to provide integrity, resilience, durability and handling quality to the finished product.

The resin coated fibre is drawn under suction onto a moving conveyor to form a mattress of fibres. This mattress passes through a gas-fired oven at approximately 250 °C, which dries the product and cures the binder. The product is then air cooled and cut to size before packaging. Edge trims can be granulated and blown back into the fibre veil, or they can be combined with surplus product to form a loose wool product.

Some products are produced without oven curing, for example, microwave cured, hot pressed, uncured or binder free products. Also certain laminated products are made by the application of a coating, for example, aluminium foil or glass tissue which is applied on line with an adhesive. Water is sprayed into much of the downstream process ducting: to prevent the build up of fibre and resinous material, which could cause fires or blockages; and to remove entrained material from the flue gas. Water is also used for cleaning the collection belt and other parts of the plant. The process water system is generally a closed loop, it is collected, filtered and reused for duct sprays, cleaning water and binder dilution.

A range of secondary products can be produced from manufactured glass fibre. These include granulated insulation wool for blown installation, packaged uncured wool for supply to customers for further processing, and laminated or faced products. Pipe insulation is a significant secondary product usually manufactured by diverting uncured wool from the main process for press moulding and curing. Alternatively, the wool may be wound onto retractable heated mandrels to form the bore and heat-processed to form the outer wall before transfer to an overall curing stage.

The binder is prepared by mixing the partially polymerised resin with certain additives that improve application efficiency, promote resin adhesion to the wool, suppress dust formation, confer water resistance and assist binder dilution. The binder is diluted with a substantial amount of water (process water where this is available) prior to application in the veil. The most commonly used resin is a thermoset product of phenol, formaldehyde and a catalyst. The resin is water-based and typically contains up to 50% solids. Resin may be imported from specialist manufacturers or may be made on-site by the mineral wool manufacturer. On-site resin production usually consists of a batch process where the raw materials are reacted under thermal control to give the desired degree of polymerisation and solids.

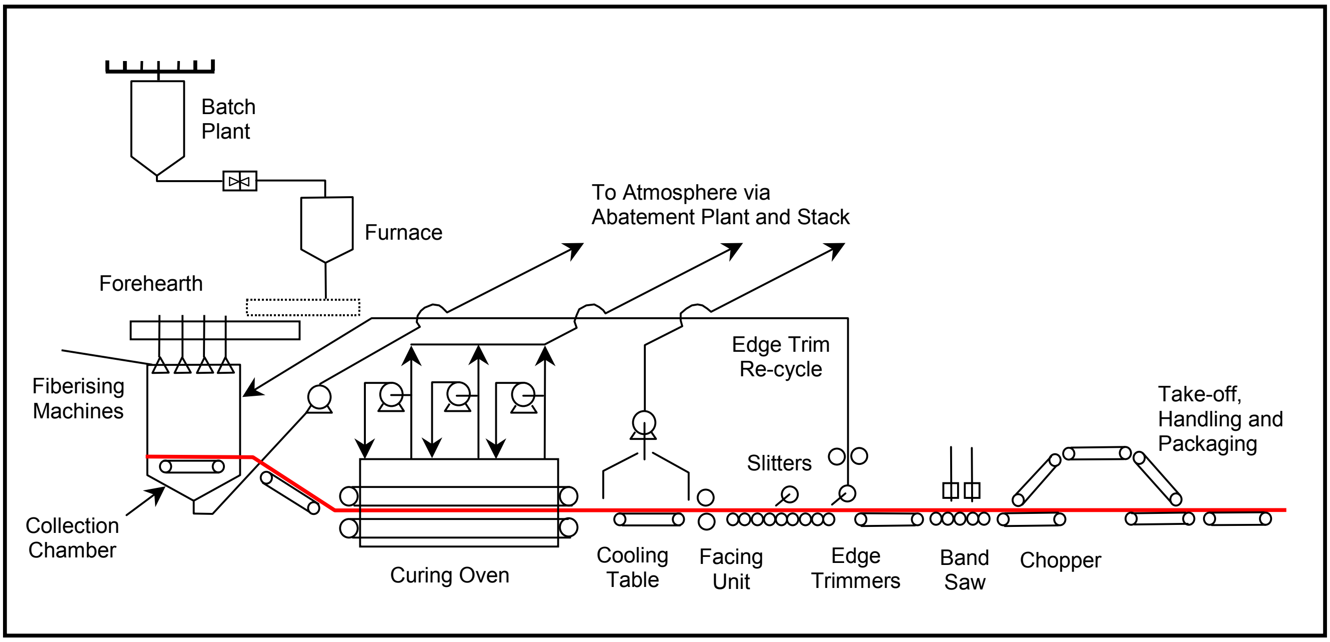

Figure 2: Generalised glass fibre insulation manufacture

1.7.3.2 Stone wool

Traditional stone wool is made by melting a combination of alumino-silicate rock (usually basalt), blast furnace slag, and limestone or dolomite. The batch may also contain recycled process or product waste. The most common melting technique is the coke fired hot blast cupola. The cupola consists of a cylindrical steel mantle which may be refractory lined and closed in at the bottom. The whole furnace surface is water cooled by means of an open, convective cooling water loop.

The raw materials and coke are charged to the top of the cupola in alternate layers, or are sometimes mixed. Air, sometimes oxygen enriched, is injected into the combustion zone of the cupola, about 1 to 2 metres from the bottom. This is the hottest part of the cupola at approximately 2000 °C. The molten material gathers in the bottom of the furnace and flows out of a notch and along a short trough positioned above the spinning machine. Basalt and to a lesser extent blast furnace slag contain iron as Fe 3+ and Fe 2+. In the reducing conditions of some areas of the cupola the ferric/ferrous iron is reduced to metallic iron. This collects in the bottom of the cupola, and would damage the expensive spinning machine if it were allowed to build up to the point where it flowed from the notch. To prevent this the iron is periodically drained, by piercing the lowest part in the curved base of the cupola.

In hot blast cupolas any fibrous or dusty material would be carried out of the top of the cupola, or would adversely affect the porosity of the bed and disrupt the flow of blast air. The accepted solution to this problem is to mill the material and produce briquettes of comparable size to the other raw materials. Cement is the usual binder for the briquettes but this can lead to higher emissions of sulphur dioxide due to the sulphur in the cement. However, briquetting provides other advantages, for example, lower energy use and the ability to add other fine materials to the batch, particularly other wastes such as foundry sand.

The melt falls onto the rapidly rotating wheels of the spinning machine, and is thrown off in a fine spray producing fibres. Air is blasted from behind the rotating wheels to attenuate the fibres and to direct them onto the collection belt to form a mattress. An aqueous phenolic resin solution is applied to the fibres by a series of spray nozzles on the spinning machine. The collection belt is under strong extraction, this performs three functions; it draws the fibre onto the belt, it removes the polluted air in the fiberising chamber, and it helps to distribute the phenolic binder across the mattress. The phenolic resin provides strength and shape to the product as in glass fibre insulation. The primary mat is layered to give the required product weight per unit area.

The mat passes through a fossil fuel-fired oven at approximately 250 °C, which sets the product thickness, dries the product and cures the binder. The product is then air cooled and cut to size before packaging. Pipe insulation and some secondary products may be manufactured in the way described for the glass wool process in the previous section.

Water can be sprayed into the ducting to prevent resin and fibre build-up, to reduce the risk of fires, and to remove entrained material from the flue gas. It is also used for a variety of cleaning operations. As in the production of glass fibre insulation the process water is collected, filtered and reused.

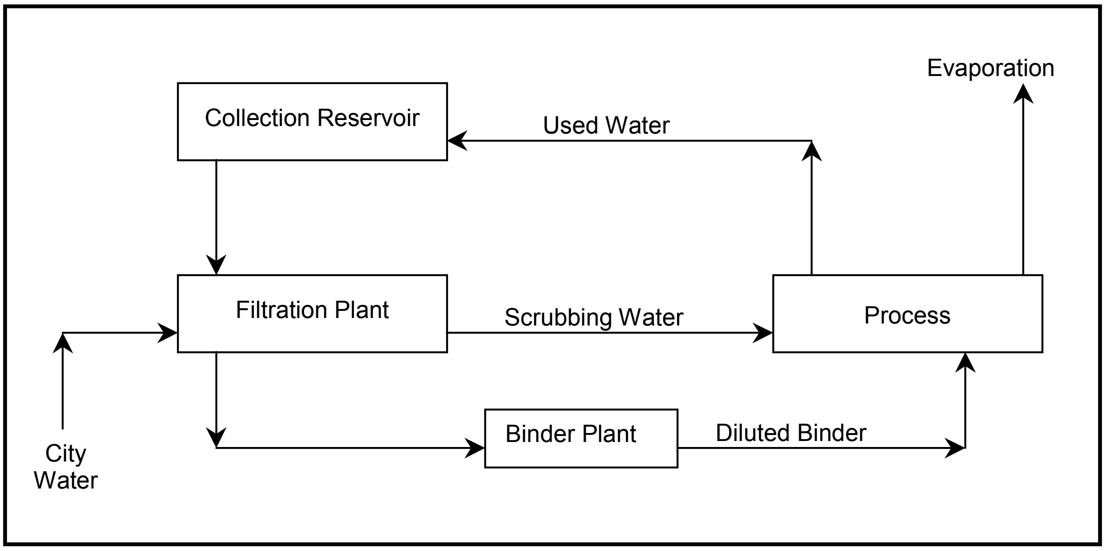

Figure 3: A typical mineral wool process water circuit

Stone wool can also be produced using flame furnaces and immersed electric arc furnaces. The other process operations including fiberising are the same. The design and operation of flame furnaces used for stone and slag wool manufacture is basically comparable to the flame furnaces used for glass wool manufacture. The furnace consists of a refractory tank heated by fossil fuel burners, either cross fired or end fired. Melting areas up to 100 m^2 are possible. Again metallic iron is reduced from the raw materials and iron tapping is necessary, for example by an orifice bushing located at the bottom of the furnace.

An immersed electric arc furnace for stone wool manufacture consists of a cylindrical steel mantle, which can be refractory, lined, and is cooled by means of either oil or water. The electrodes are immersed into the molten mass from the top of the furnace, providing energy for melting by resistive heating. The raw materials are inserted from above to provide a material blanket over the melt surface (cold top). Due to the electrode arrangement, however, there is always an open melt bath around the electrodes. Alternatively the electric furnace can operate with only partial coverage of the melt surface (hot top). Graphite electrodes are used and, as a result, a small amount of free metallic iron is reduced from the raw materials. Iron tapping is necessary, but at a much lower frequency (once per week or less) than for cupola furnaces.

1.7.4 Ceramic fibre

The process can be divided into two parts, the production of the fibre and the conversion of the fibre into other components.

Large volume raw materials (that is oxides of aluminium, calcium, magnesium, silicon and zirconium) are delivered in bulk road tankers and pneumatically transferred to bulk storage silos. Smaller volume raw materials, including organic additives, are received in and dispensed from drums or sacks. The bulk raw materials are transferred from storage to the blending plant where they are mixed to give the required composition. The blended material is transferred to the furnace, where it is melted by electrical resistive heating at temperatures up to 2000 °C.

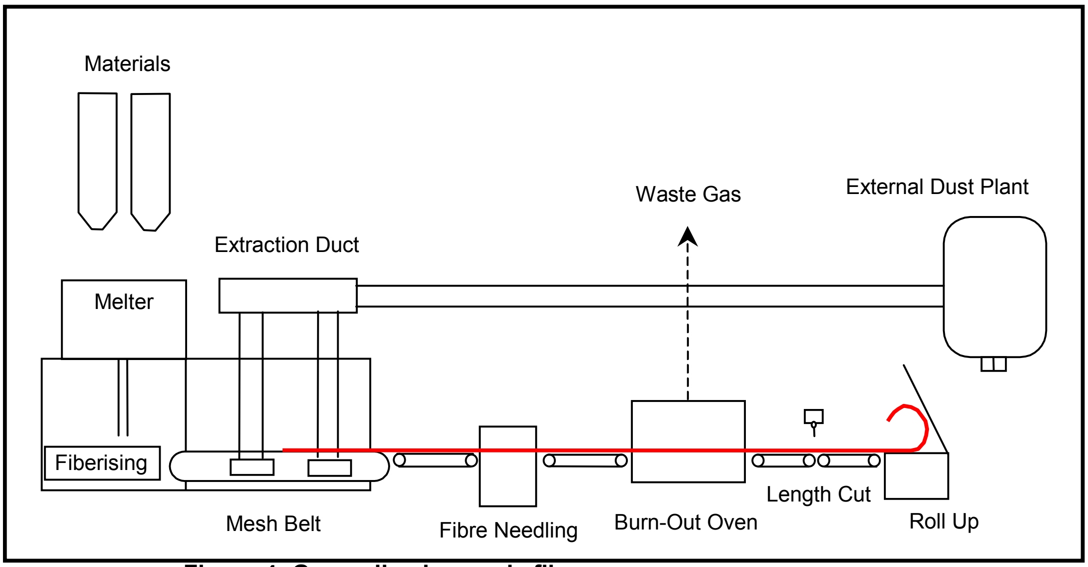

Figure 4: Generalised ceramic fibre process

The melt flows from the furnace to fall either onto high speed rotating wheels, which throw off a spray of fibres into a collecting chamber, or alternatively, in front of a high pressure air jet which attenuates the molten material into fibres. In neither case are binders added to the fibres, but a small amount of lubricant may be added which aids needling. If the fibre production is interrupted the molten stream is not stopped, it is quenched in water and where practicable reused in the process.

The fibres are drawn from the collecting chamber on to a continuously moving belt to which a vacuum can be applied. As the resulting fleece comes off the lay-down belt it can be removed, baled and bagged, or allowed to continue down the production line to make blanket. This material can be baled as product or needle felted to knit the fibres together for additional strength. The needle-felted product can be passed through an oven to remove lubricant before being rolled up as blanket or cut into sized pieces.

Further downstream processing may also be carried out. The vacuum forming process consists of supplying a wet colloidal mixture of starch, latex, silica or clay to appropriately shaped moulds. The moulded shape is usually dried in a gas-fired oven, and may be buffed or trimmed and cut to size before packing and dispatch. Papers, felts and boards may also be produced. This involves the laying down of an aqueous suspension of fibres onto a vacuum drum, followed by oven drying. A mixture of binders and additives may be added to the aqueous suspension.

1.7.5 Frit

Frit is prepared by fusing raw materials in a melter at high temperature. The molten material is then quenched causing the melt to solidify rapidly and shatter into friable particles termed frit. Glass frit is used as a raw material in the production of ceramic glaze. Similarly, enamel frit is a raw material used in the production of enamel. Glazes and enamels may be applied either dry or wet, the latter predominates and is usually in the form of a slip or slurry.

The raw materials used in glass and enamel frit manufacture are essentially the same. They can be divided into four different groups, refractories, fluxes, opacifiers and colouring agents. Refractories include materials such as clay, feldspar and quartz. They are generally acidic in character and provide body to the frit. Fluxes are basic in character and react with the acidic refractories to form the glass. They include materials such as soda ash, potash, borax, cryolite and fluorspar. Opacifiers provide the white opaque appearance that characterises many enamels. They can be insoluble such as titanium dioxide, tin oxide and zirconium oxide, or devitrification opacifiers such as cryolite or fluorspar. The latter may also act as fluxes rendering enamels more fusible. Opacifiers are not always included at the fritting stage, but may instead be added during slip production. Colouring agents may be oxides, elements or salts. Aside from their colouring properties they may act as either refractories or fluxes, and include materials such as cobalt oxide, chromium oxide and manganese oxide.

Raw materials may be stored in silos and conveyed to the weighing area pneumatically or mechanically. However, due to the relatively small size of some manufacturers many materials are stored in bags and manually dosed to the weighing apparatus. The various raw materials are precisely weighed and mixed to produce a batch that is chemically and physically uniform before being charged to the furnace.

The frit industry utilises both continuous furnaces and discontinuous batch furnaces. The choice of furnace is dependent on the scale of production and the product formulation. The nature of the business is such that it is common for small batches to be produced for a wide range of frit formulations. Frit furnaces are generally natural gas or oil fired, and most modern frit plants in Europe use oxy-fuel firing.

In continuous furnaces the raw materials are charged via a screw-feeder and form a pile at the charging point. Burners located along the sides provide temperature conditions of appropriate stability to enable the face of the pile to melt continuously. Smaller continuous furnaces may be end-fired with a single burner. As the materials melt, they form a shallow layer on the base of the furnace and flow to emerge at the opposite end. Production remains constant due to the continuous feeding of the raw material pile at the inlet. The molten frit can be quenched directly in a water bath, or can be cooled between water cooled rollers to produce a flake product.

Discontinuous batch furnaces are box shaped or cylindrical refractory lined vessels, mounted on bearings to allow a degree of rotation. To avoid contamination such furnaces are normally dedicated to similar types of formulation, though it is possible to purge furnaces between melts. Raw materials are charged through a port at the top of the furnace, and this can result in a short-term high level of particulate matter emission. Direct water quenching is used almost exclusively in batch manufacture, and the quench water may become contaminated with particulate matter and any soluble components from the melt. Temperatures in the furnace are typically in the range 1000 °C to 1500 °C, though lower temperatures are used for high lead frits. During the melting operation metal fume and other particulates may be generated. Residence time in the furnace is typically less than 4 hours.

To produce a slip, the frit must first be finely ground. Grinding is generally carried out in ball mills utilising alumina balls or flint pebbles in water. Further constituents of the glaze or enamel, such as clays, colours, electrolytes and opacifiers, may be added at any desired stage in the grinding cycle. Mill cycle times may vary from 6 to 16 hours. On completion of the milling operation the blended slip is passed over a mesh screen and over a magnet to remove tramp iron. For dry products the resulting slip may be dried or a dry grinding process may be used.

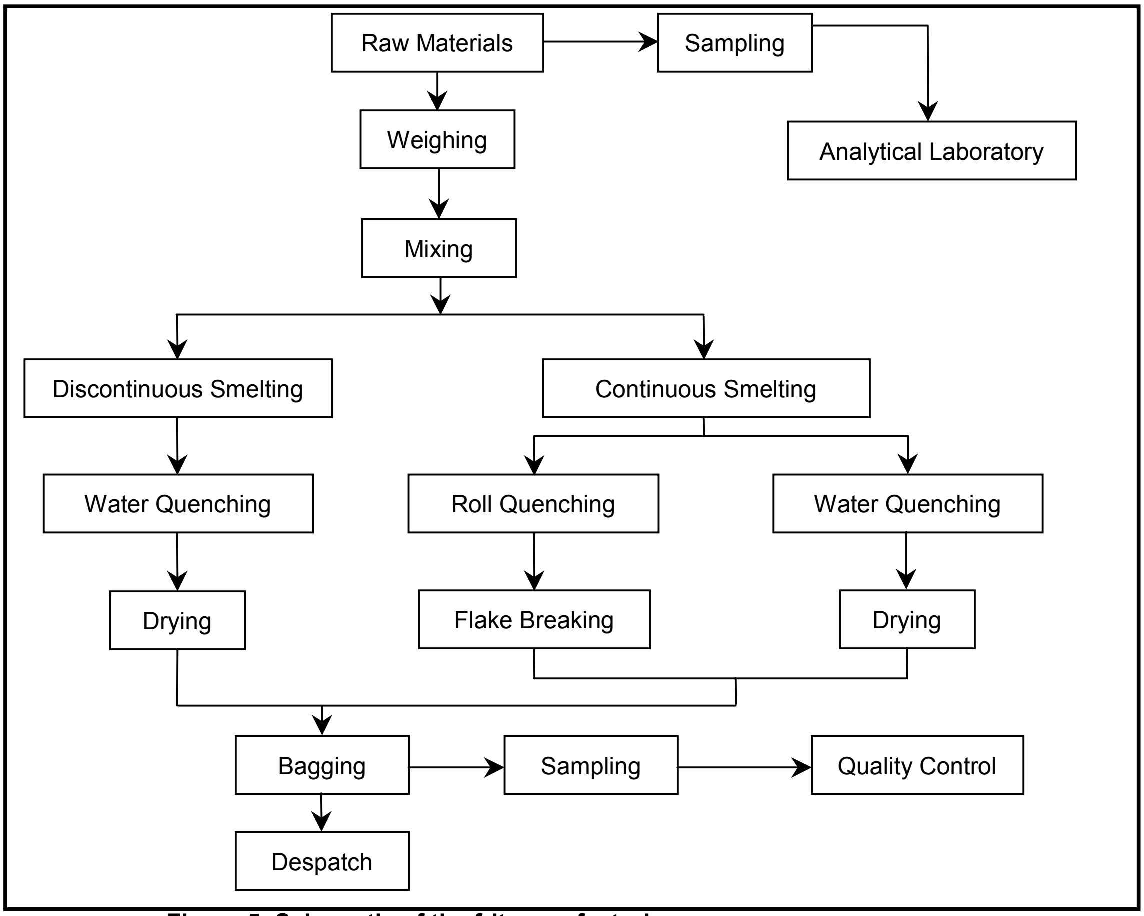

Figure 5: Schematic of the frit manufacturing process

1.7.6 Optical fibre

There are three major processes for optical fibre manufacturing. The processes Modified Chemical Vapour Deposition (MCVD), Outside Vapour Deposition (OVD) and Vapour Axial Deposition (VAD), all use silicon tetrachloride and small amounts of germanium tetrachloride to manufacture high purity glass with well controlled optical properties. The processes vary in the way in which the particles of glass are produced and collected.

In the MCVD process, the inside of a glass tube is cleaned by a chemical etching process. Freon gas and oxygen are passed down the tube, whilst the outside is heated with a flame burner which traverses along the length of the tube. The inside of the tube is coated with layers of cladding glass, by the vapour deposition of silicon dioxide. Silicon tetrachloride is passed down the glass tube, the outside of which is heated with a longitudinally moving flame burner. The silicon tetrachloride is oxidised to silicon dioxide soot, which is deposited on the inside of the tube and fused into a glass by the heat of the burner. Many layers of soot are deposited and fused into glass. Finally, the cylinder is collapsed to remove the centre hole and produce a glass preform.

In the OVD process, silicon tetrachloride is passed through a flame burner and oxidised to fine particles of silicon dioxide soot. The soot is deposited on the outside of a target rod, which is passed back and forth through the flame. Many layers of soot are deposited on the rod to create a soot preform. This preform is later placed in a consolidation furnace where heat and process gases, chlorine and helium, are used to fuse the soot into glass, to close the hole left by removal of the target rod and to remove any water.

The VAD process is similar to the OVD process except that the soot particles are deposited on the end-face of the target rod instead of along its length. To make room for new growth, the target rod is moved away from the flame burner. The soot preform is consolidated in a manner similar to the description above. This glass preform is sometimes inserted into a glass tube, similar to that used as the starting tube for MCVD, to make the preform larger.

Any undeposited soot and reaction by-products (predominantly chlorine and hydrogen chloride) are extracted to pollution abatement equipment. Acidic gases from preform consolidation pass to the pollution abatement equipment as well. The final stage of the manufacturing process involves drawing the glass cylinder into a filament, coating the filament with an acrylic resin, curing the resin using ultraviolet light and winding the filament onto a reel. The reel of optical fibre is then tested for strength and optical properties before being wound onto a reel for storage and then sale.

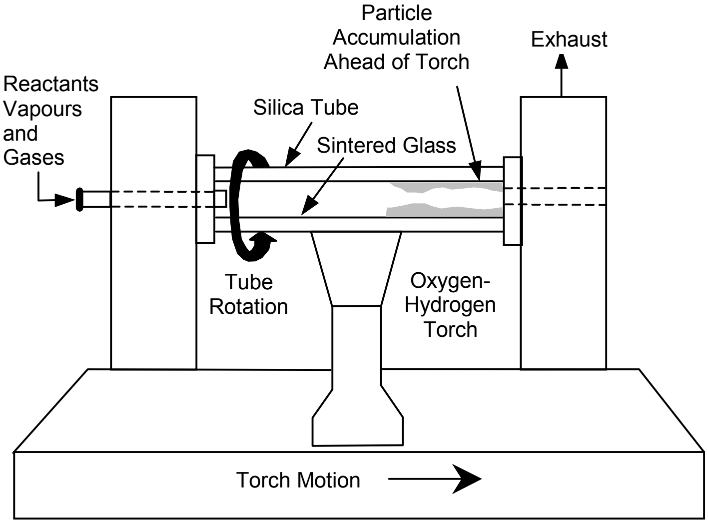

Figure 6a: Optical fibre manufacture

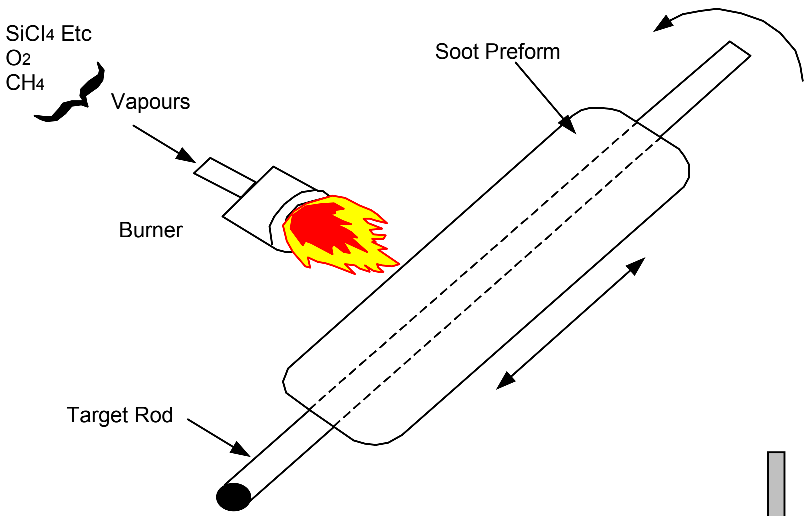

Figure 6b: Optical fibre manufacture - OVD soot preform process

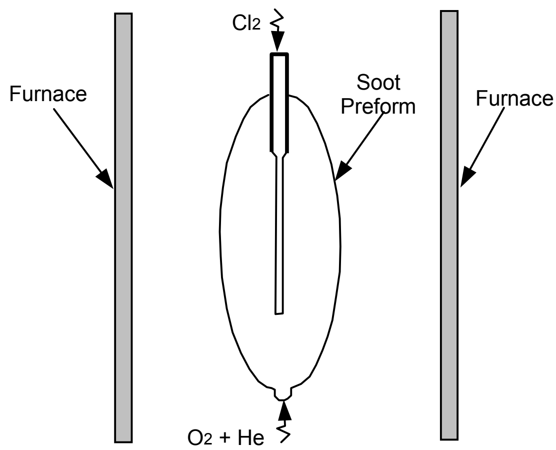

Figure 6c: Optical fibre manufacture

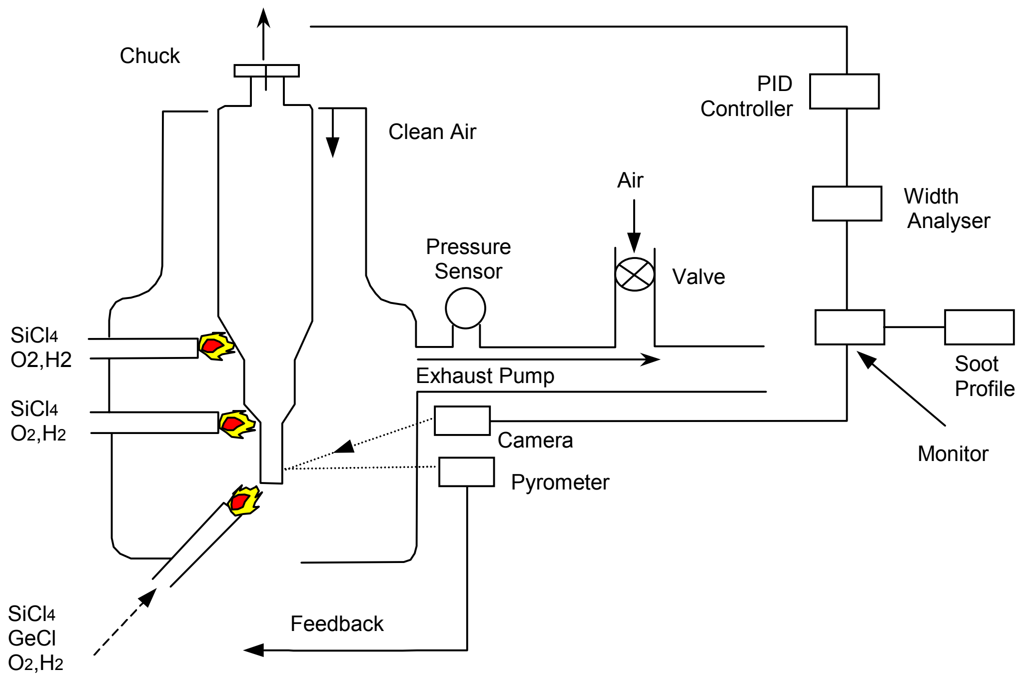

Figure 6d: Optical fibre manufacture

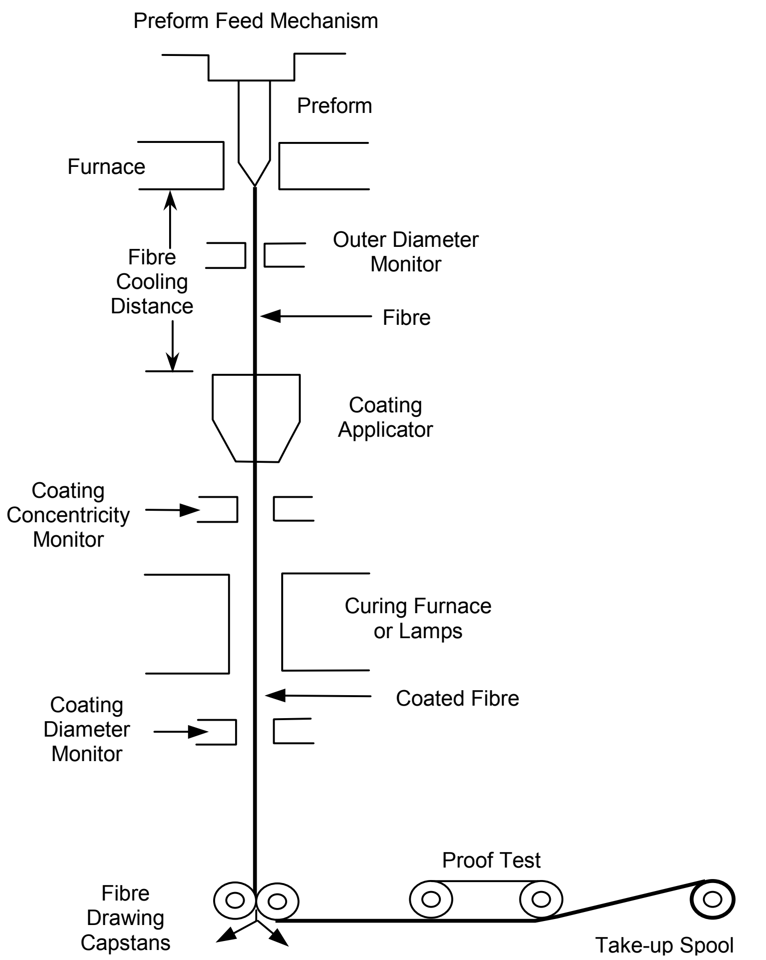

Figure 6e: Optical fibre manufacture

1.8 Economic aspects for each sector

The Glass Industry is essentially a commodity industry, although many ways of adding value to high volume products have been developed to ensure the industry remains competitive. Over 80% of the industry output is sold to other industries, and the Glass Industry as a whole is very dependent on the building, and the food and beverage industries. However, this general picture is not true for all of its components, as some of the smaller volume sectors produce high value technical or consumer products.

Many of the sectors within the Glass Industry utilise large continuous furnaces with lifetimes up to twelve years. These furnaces represent a large capital commitment and the continuous operation of the furnace and the rebuild provide a natural cycle of investment in the process. Major changes of melting technology are most economically implemented if coincided with furnace rebuilds. This can also be true for complex secondary abatement measures that must be correctly sized and any necessary gas conditioning implemented. However, many improvements to the operation of the furnace, including the installation of secondary techniques, are possible during the operating campaign. For smaller furnaces with more frequent rebuilds and lower capital costs, the advantages of co-ordinating environmental improvements and furnace repairs are less significant, but environmental improvements may be more economical if co-ordinated with other investments.

1.8.1 Products and markets

Sector	Product	Main end use	Main market
Continuous filament glass fibre	Roving, mat, chopped strand, textile (yarn), tissue, milled fibre	Reinforcement of composites; for example thermosetting resins and thermoplastics	Building industry, automotive and transport, electrical/electronics (printed circuit boards), pipes, tanks, agricultural equipment, industrial machinery, sports, marine and leisure industries.
Mineral wool	Low density insulation rolls; medium and high density slabs; loose wool for blowing and pipe insulation	Insulation. Stone wool favoured for high temperature or fire protection; glass wool more frequent where light weight critical	Building thermal insulation, heating and ventilation, industrial applications, fire protection, acoustics, inert growing media, soil conditioning
Ceramic Fibre	Vitreous, siliceous fibrous material – bulk fibre, blanket (felt or nodules), board, paper, vacuum formed articles and textiles	High temperature insulation	Furnace and heater lining, appliances, metals processing, general industrial insulation, automotive, fire protection
Frits	Flake, slip	Glass frit – manufacture of ceramic glazes and pigments. Enamel frit – manufacture of enamel glazes for coating of metal surfaces	Ceramic ware manufacturers. Manufacture of cooking equipment – coating for hobs, ovens, grills etc. Also: storage tanks, silos, baths, electronic components, signs
Optical Fibre	High purity glass with well controlled optical properties	Fibre optic cables	Telecommunications applications (replacement for copper wires)

1.8.2 Cost information

The following Table summarises estimated costs of abatement as detailed in the BREF note. Only examples of processes applicable to this note have been included. Cost information in the BREF was given in euros. All costs listed in this Table have been converted to sterling using an exchange rate of £1.56 to 1 euro, as at 1 March 2001.

Activity	Size	Capital (£M)	Operational (£M/y)	Comment
MELTING				
EP + acid gas scrubbing	100 tonne/d glass filament process		0.09	Source:BREF No information available on capital costs.
Bag filter	-	-	-	Investment costs are generally lower than an EP; running costs are higher. Often smaller plants favour bag filters due to lower capital costs and because for low air flows the operating costs are proportionally reduced. Source: BREF
Bag filter + dry scrubbing	Stone wool plant	0.9 – 2.2	-	Source: BREF Estimaed costs for a new plant. Costs approximately +20% for an existing plant.
Combustion modification, e.g. low NOx burners	Various	0.2 – 0.9 per furnace. Add 0.1 for monitoring and control systems.		Source: BREF
Chemical reduction by fuel: - 3R process - Reburning	- 125 tonne/d glass fibre furnace	Up to 0.5 0.5	- variable	Source: BREF
SCR with EP and acid gas scrubbing	100 tonne/d glass fibre furnace (12000Nm^3/hr)	3.1 – 4.7	0.2	Source: BREF
SCR	100 tonne/d glass fibre furnace	-	0.1	Source: BREF
SNCR	100 tonne/d glass fibre furnace	-	0.03 – 0.05	Source: BREF
Low NOx	100 tonne/d glass fibre furnace	-	0.03	Source: BREF
Oxy-fuel firing	100 tonne/d glass fibre furnace	-	0.3	Source: BREF
SCR + filter	100 tonne/d glass fibre furnace	-	0.2	Source: BREF
Filter + scrubber	100 tonne/d glass fibre furnace	-	0.09	Source: BREF

Activity	Size	Capital (£M)	Operational (£M/y)	Comment
FORMING AND CURING				
Impact scrubber + cyclone	200000 Nm^3/hr (-50000, +100000)	2.03 ± 30% (2.5 ± 40%)	0.16 ± 0.03	Source: BREF Figures are for a new process. Figures in brackets are the investment cost for an existing factory.
Impact scrubber + cyclone + WEP	200000 Nm^3/hr (-50000, +100000)	5.9 ± 30% (7.1 ± 40%)	0.18 ± 0.03	Source: BREF Figures are for a new process. Figures in brackets are the investment cost for an existing factory.
Impact scubber + cyclone + PBS	200000 Nm^3/hr (- 50000, +100000)	5.5 ± 30% (6.5 ± 40%)	0.33 ± 0.03	Source: BREF Figures are for a new process. Figures in brackets are the investment cost for an existing factory.
FORMING ONLY				
Stone wool slab filter	200000 Nm^3/hr (± 50000)	2.02 ± 30% (2.3 ± 30%)	0.3 ± 0.15	Source: BREF Figures are for a new process. Figures in brackets are the investment cost for an existing factory.
CURING ONLY				
Incinerator	20000 Nm^3/hr (-5000, +10000)	2.02 ± 40% (2.5 ± 30%)	0.3 ± 0.15	Source: BREF Figures are for a new process. Figures in brackets are the investment cost for an existing factory.
STACK	250000 Nm^3/hr (-50000, +100000)	1.1 ± 40% (1.2 ± 40%)		Source: BREF Figures are for a new process. Figures in brackets are the investment cost for an existing factory.

2 TECHNIQUES FOR POLLUTION CONTROL

BAT Boxes to help in preparing applications

This section summarises, in the outlined BAT boxes:

- what is required in the application,
- the indicative BAT requirements (that is what is BAT in most circumstances) against which the application will be judged.

At the top of each BAT box is the question which is being addressed. It will be seen that these deal with the questions in the Application Form relating to environmental performance of the installation.

Although referred to as BAT, the requirements also cover the other requirements of the PPC Regulations and those of other Regulations such as the Waste Management Licensing Regulations and the Groundwater Regulations (see Appendix 2 for equivalent legislation in Scotland and Northern Ireland insofar as they are relevant to an IPPC Permit).

Indicative BAT requirements

Where it is possible for the Regulator to judge on what will normally be the BAT, the, indicative requirements are clear and prescriptive. In such cases:

- If you propose to comply with the indicative requirement, you need only describe how you will do so, if this is not obvious from the wording of the requirement itself.
- If you propose to depart from any indicative requirements, you should justify your proposal. Such departures may be stricter or less strict than the indicative requirements:
- Stricter proposals may be appropriate where:
  - new techniques have become available after the publication of the guidance;
  - the particular technical configuration at your installation makes higher standards practicable;
  - the local environment is particularly sensitive.
- Less strict proposals may be justified due to particular factors relating to your installation or the local environment. For example, you may operate to a standard that is very close to an indicative requirement, but using different plant or processes from those upon which the indicative requirement is based. In such a case it might impose a disproportionate cost to replace the old plant with the new techniques for only a small decrease in emissions.

In other cases, the main BAT candidates are identified, but the final choice can only be made on an installation-specific basis. Sometimes, aspects of the installation may not be covered by the guidance at all.

Justifying proposals

The costs and benefits of a range of options should be compared whether you are:

- justifying departures from clear indicative requirements;
- assessing options to determine which of those identified by guidance is best for a your site; or
- developing proposals for parts (or possibly all) of an installation that are not covered by guidance.

However, the level of detail required depends on the environmental significance of the matter in question. In more complex cases (for example where the options available would lead to significantly different environmental effects, or where the cost implications are a major factor) you will be need to develop proposals through a more detailed analysis of the costs and benefits of options. The Regulator's methodology for such assessments is set out in the IPPC H1 *Assessment of BAT and Environmental Impact for IPPC* (in preparation).

In many situations, however, you will not need to carry out a detailed analysis of options. For example, where an indicative standard is inappropriate for obvious technical reasons, or where there are only minor additional emissions, it may be possible to justify a departure in just a few words – see also section 1.2.

Prevention is the priority.

In responding to the requirements the Operator should keep the following general principles in mind.

- As a first principle there should be evidence in the application that full consideration has been given to the possibility of *preventing* the release of harmful substances, for example by:
  - substituting materials or processes (see Section 2.2.1);
  - preventing releases of water altogether (see Section 2.2.3); or by
  - preventing waste emissions by reuse or recovery.
- Only where that is not practicable should the second principle be adopted of reducing emissions that may cause harm.

Further explanation of the requirements of Section 2 is given in Section B2 of the *Guide for Applicants*.

Techniques in green text (viewable on electronic versions) are additional to the BREF requirements.

2.1 Management techniques

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. The Regulators strongly support the operation of environmental management systems (EMSs). An Operator with such a system will find it easier to complete not only this section but also the technical/regulatory requirements in the following sections.

The Regulators recommend that the ISO 14001 standard be used as the basis for an environmental management system. Certification to this standard and/or registration under the EC Eco Management and Audit Scheme (EMAS), (Official Journal OJ L168, 10.7.93) are also strongly supported by the Regulator. Both certification and registration provide independent verification that the Environmental Management Scheme (EMS) conforms to an assessable standard. EMAS now incorporates ISO 14001 as the specification for the EMS element. For further details about ISO 14001 and EMAS contact British Standards Institute (BSI) and the Institute of Environmental Management and Assessment (IEMA) respectively.

The steps required in this and subsequent sections may help the Operator to make good any shortfalls in his management system. An effective EMS will help the Operator to maintain compliance with regulatory requirements and to manage other significant environmental impacts. Although the requirements below are considered to be BAT for IPPC, they are the same techniques as required in a formal EMS and are also capable of delivering wider environmental benefits. However, it is information on their applicability to IPPC that is primarily required in this application.

Application form Question 2.1

Provide details of your proposed management techniques.

With the Application the Operator should:

1. Describe his management system to demonstrate how it meets the *Requirements for an effective management system* below. The description should make clear who holds responsibility for each of the requirements. The second column explains where in the application the response to each requirement is best dealt with to avoid duplication. Copies of all procedures are not needed, but examples may be included in your application.

   If you are certified to ISO 14001 or registered under EMAS (or both) you may provide a statement derived from certification records/assessments to support your application.

   Further specific management procedures are dealt with under the appropriate section on the remainder of the document. We recommend that you understand all the requirements of the application before completing this section, as many management issues are dealt with in other sections.

2. The type of management system employed will depend upon the scale and complexity of the operations undertaken. The Operator should demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements below, or by justifying departures (as described in Section 1.2 and in the *Guide for Applicants*) or alternative measures.

Indicative BAT requirements

BAT for management techniques

The Operator should have a management system in place for the activities which delivers the requirements given in column 1 below. The development of any aspects of the management system not already in place should be completed within the timescale given in Section 1.1.

Requirement for an effective management system	How delivered for IPPC
1. **Clear management structure and allocated responsibilities** for environmental performance, in particular meeting the aspects of the IPPC Permit	Describe in this section who has allocated responsibilities
2. **Identification, assessment and management of significant environmental impacts**	By responding to the requirements in Section 4.1 in the application
3. **Compliance with legal and other requirements applicable to activities impacting on the environment**	Compliance with the Permit satisfies this requirement

Cont.

4. **Establishing an environmental policy and setting objectives and targets** to prevent pollution, meet legal requirements and continually improve environmental performance	The Applicant should make proposals in response to each of Sections 2.2 to 2.12. These proposals may be incorporated within the Permit improvement programme
5. **Environmental improvement programmes to implement policy objectives and targets**	
6. **Establish operational controls to prevent and minimise significant environmental impacts**	By responding to the requirements in Sections 2.2 to 2.7, 2.11 and 2.12 in the application
7. **Preventative maintenance programmes for relevant plant and equipment** – method of recording and reviews	Describe system here. List procedures in Section 2.3
8. **Emergency planning and accident prevention**	By responding to the requirements in Section 2.8 in the application
9. **Monitoring and measuring performance** Identify key indicators of environmental performance and establish and maintain a programme to measure and monitor indicators to enable review and improvement of performance	Describe in this section
10. **Monitoring and control systems**: • to ensure that the installation functions as intended; • to detect faults and unintended operations; • to detect slow changes in plant performance to trigger preventative maintenance	By responding to the requirements in Section 2.10 in the application
11. **Training** Provision of adequate procedures and training for all relevant staff (including contractors and those purchasing equipment and materials), which should include: • a clear statement of the skills and competencies required for each job; • awareness of the regulatory implications of the Permit for the activity and their work activities; • awareness of all potential environmental effects from operation under normal and abnormal circumstances; • prevention of accidental emissions and action to be taken when accidental emissions occur; • implementation and maintenance of training records. Expertise required depends on the activities being carried out. However, both technical and managerial staff upon whom the installation's compliance depends need sufficient qualifications, training and experience for their roles. This may be assessed against any industry sector standards or codes of practice	In this section confirm that training for each of the areas covered by Sections 2.2 to 2.3 and 2.5 to 2.10 are covered
12. **Communication and reporting of incidents of actual or potential non-compliance and complaints** Actions taken in response, and about, proposed changes to operations	Describe in this section
13. **Auditing** Regular, preferably independent, audits to check that all activities are being carried out in conformity with these requirements. All these requirements should be audited at least annually	Describe in this section

Cont.

14. **Corrective action to analyse faults and prevent recurrence** Define responsibility and authority for handling and investigating non-conformity, taking action to mitigate any impacts caused and for initiating and completing corrective and preventive action . Recording, investigating, taking corrective action and preventing recurrence, in response to environmental complaints and incidents	Describe in this section how this is dealt with for each of Sections 2.2 to 2.3 and 2.5 to 2.10 as appropriate
15. **Reviewing and reporting environmental performance** Senior management review environmental performance and ensure appropriate action is taken where necessary to ensure that policy commitments are met and that policy remains relevant. Review progress of the management programmes at least annually.	Describe in this section
Incorporate environmental issues in all other relevant aspects of the business, insofar as they are required by IPPC, in particular: • the control of process change on the installation; • design and review of new facilities, engineering and other capital projects; • capital approval; • the allocation of resources; • planning and scheduling; • incorporation of environmental aspects into normal operating procedures; • purchasing policy; • accounts and report on environmental costs within the company management systems against each process/product and not allocated as an overhead.	Describe in this section
Report on environmental performance, based on the results of management reviews (annual or linked to the audit cycle), for:	This will become a Permit requirement
• information required by the Regulator;	Describe in this section
• effectiveness of the management system against objectives and targets, and future planned improvements; • report audited environmental costs, savings and environmental benefits in published annual reports and accounts. Report externally, preferably via public environmental statement	Describe in this section
16. **Managing documentation and records** List the core elements of the EMS (policies, responsibilities, procedures and the like) and links to related documentation in order to be able to control, locate and update documentation. Describe how environmental records and results of audits and reviews are identified, maintained and stored	Describe in this section

Selection of raw materials

2.2 Materials inputs

This section covers the use of raw materials and water and the techniques for both minimising their use and minimising their impact by selection. (The choice of fuels is covered under Section 2.7.3, Energy).

As a general principle, the Operator will need to demonstrate the measures taken to:

- *reduce* the use of chemicals and other materials (Section 2.2.2);
- *substitute* less harmful materials, or those which can be more readily abated and when abated lead to substances that are more readily dealt with;
- *understand* the fate of by-products and contaminants and their environmental impact (Section 4).

2.2.1 Raw materials selection

This section looks at the selection and substitution of raw materials used, while Section 2.2.2 describes the techniques to minimise their use.

Summary of materials in use

Glass Industry raw materials are largely solid inorganic compounds, either naturally occurring minerals or man-made products. They vary from very coarse materials to finely divided powders. Liquids and gases are also widely used, both as ancillary materials and as fuels. Most of the minerals used occur naturally in abundance and in general there are no major environmental issues associated with the provision of these materials. Process residues (such as recycled dust from process abatement systems) and post consumer materials are becoming increasingly important as raw materials for the Glass Industry, particularly in the Mineral Wool sector. Ancillary materials are substances which are used in the manufacture of the products but which do not form part of the final product, for example, oxygen in oxy-fuel fired systems.

It should be recognised that the process of selecting raw materials can present an opportunity to control emissions at source. In this regard it is suggested that operators closely examine the range of possible raw material recipes available to them.

Raw materials used in continuous filament glass fibre production

BREF section 2.6 and Tables 3.12 and 3.13

The chemical composition of the fibre varies depending on the glass type and the end use, and is usually expressed in terms of the oxides of the elements it contains. It is difficult to identify a “typical” batch composition beyond that given in the BREF. The basic raw materials are selected and blended to give the final desired glass compositions following melting. The typical glass types and composition ranges are shown in Chapter 2 of the BREF. Table 3.13 in the BREF shows the main raw materials used to achieve these compositions. The largest inputs to the process are the silica sand, the alkali/alkali earth metal carbonates and oxides, alumina and the boron containing materials. In the E glass composition the oxides of silicon, sodium, potassium, calcium, magnesium, boron and aluminium account for over 95 % of the glass. The dominant oxides and the main materials from which they are derived are: SiO_2 (53 - 60% - sand); CaO+MgO (20 - 24% - limestone, dolomite); B_2O_3 (0 - 10% - colemanite, borax, etc); Al_2O_3 (11 - 16% - alumina); and Na_2O+K_2O (<2% - soda ash/potash). Coating materials represent a very small proportion of the product mass, typically 0.5% to 2%. They consist mainly of aqueous polymer solutions, typically 50% solids, and smaller amounts of the other materials specified in Table 3.13 in the BREF.

Raw materials used in mineral wool production

BREF section 2.9 and Table 3.22

The chemical composition of mineral wool can vary widely, and is generally expressed in terms of the oxides of the elements it contains. It is difficult to identify a “typical” batch composition for any of the main types of mineral wool, that is, glass wool, stone wool or slag wool. The basic raw materials are selected and blended to give the final desired glass compositions following melting. The percentage of each raw material in the batch can vary significantly particularly where substantial amounts of recycled materials are used. The characteristic composition ranges for glass wool, stone wool and slag wool are shown in Chapter 2 of the BREF. Table 3.22 in the BREF shows the range of raw materials that may be used to achieve these compositions.

In glass wool the main oxides are silicon dioxide, oxides of alkali metals (predominantly sodium and potassium) and oxides of alkali earth metals (predominantly calcium and magnesium). The most significant sources of silicon dioxide are sand and waste glass materials, that is cullet and fibrous wastes. The most significant sources of alkali and alkali earth metal oxides are soda ash, potash, limestone, dolomite and to a lesser extent recycled glass.

In stone/slag wool the main oxides are silicon dioxide and oxides of alkali earth metals (predominantly calcium and magnesium). The silicon dioxide is derived principally from basalt, briquetted recycled material and blast furnace slag. The alkali earth metal oxides are derived from limestone, dolomite and briquetted recycled material. Some stone wool and slag wool have significant levels of aluminium

Selection of raw materials

oxide which is derived from blast furnace slag, basalt and recycled materials. Some low alumina formulations are produced from batches with significant levels of foundry sand and glass cullet rather than only basalt and slag.

The proportion of mineral wool to binder will vary depending on the product application. Typically mineral wool products contain 95 to 98% by mass of fibre. Some very rare products will have a maximum of 20% binder with 1% mineral oil and 0.5% of miscellaneous ingredients (for example, silicone). Stone/slag wool products usually contain lower proportions of binder compared to glass wool products for similar applications. This is because densities of products fulfilling similar application requirements differ between glass wool and stone/slag wool. Stone wool may be up to twice the density of glass wool to achieve the same thermal insulation performance, particularly for low-density products.

In common with all processes in the Glass Industry a significant mass of the raw materials will be released as gases on melting. This will depend mainly on the amount of recycled material used, but for a typical mineral wool process the ignition losses will be generally around 10%. Higher levels may be observed if high levels of carbonaceous materials are used in the batch.

Binder raw materials are generally manufactured liquid chemicals, although powdered solid chemicals are sometimes used. Binder formulations are generally considered as confidential and are not disclosed. The phenolic resin can be either manufactured on-site or bought from an external supplier. This choice will have little impact on the emissions from the mineral wool process itself, but clearly there are consumption and emission issues associated with resin manufacture. These issues are not covered within the scope of this document and reference should be made to appropriate guidance material for the Chemical Industry.

Raw materials used in ceramic fibre production

BREF section 2.10 and Table 3.30

There are two main product formulations high purity alumina-silicate and zirconia alumina-silicate, the compositions of which are given in Chapter 2 of the BREF. The main raw materials are given in Table 3.30 in the BREF, they are a combination of natural (usually processed) and man-made substances.

The raw materials for the melt are blended to give the required compositions on melting. In general over 90 % of the composition is derived from the oxides of silicon, aluminium and zirconium. Silicon dioxide is derived mainly from high-grade silica sand, and aluminium oxide (alumina) can occur naturally but is usually derived by processing bauxite. Zirconium dioxide occurs naturally as baddeleyite or can be manufactured.

Raw materials used in frit production

BREF section Table 3.31

The main raw materials used for the most common formulations are given in Table 3.31 in the BREF, along with an indicative batch composition. The precise figures will vary but those in the table are broadly indicative.

Raw materials used in Optical fibre manufacture

See Section 1.7.6.

Selection of raw materials

Application form
Question 2.2 (part 1)

Identify the raw and auxiliary materials, other substances and water that you propose to use.

With the Application the Operator should:

1. Supply a list of the materials used, which have the potential for significant environmental impact, including:
   - the chemical composition of the materials where relevant;
   - the quantities used;
   - the fate of the material (i.e. approximate percentages to each media and to the product);
   - environmental impact where known (for example. degradability, bioaccumulation potential, toxicity to relevant species);
   - any reasonably practicable alternative raw materials that may have a lower environmental impact including, but not limited to any alternatives described in the BAT requirements below (the substitution principle).

   A suitable template is included in the electronic version of this document.

   Generic information about materials, and grouping information about those of a similar type, is normally adequate, rather than listing every commercial alternative used. A common-sense approach to the level of detail should be used, ensuring that any material that could have a significant effect on the environment is included. Product data sheets should be available on-site.

2. Justify (for example, on the basis of impact on product quality) the continued use of any substance for which there is a less hazardous alternative to show that the proposed raw materials are therefore BAT;

3. For existing activities, identify shortfalls in the above information, such as the environmental impact of certain substances, which the Operator believes require longer-term studies to establish.

Indicative BAT requirements

BAT for selection

1. The Operator should complete any longer-term studies (Item 3, above) or carry out any substitutions identified as improvement conditions in accordance with a timescale to be approved by the Regulator.

2. The Operator should maintain a detailed inventory of raw materials used on-site.

3. The Operator should have procedures for the regular review of new developments in raw materials and the implementation of any suitable ones that are less hazardous.

4. The Operator should have quality-assurance procedures for controlling the content of raw materials.

5. The Operator should state the percentage of furnace slag used as a raw material and justify the use of slag. Justification is required when slag use cannot be replaced by recycled process waste.

6. Ammonia used for Selective Catalytic Reduction (SCR) must be stored and handled correctly, that is standard liquid bulk storage (and bunded, see Section 2.3.9) and under pressure.

7. For mercury levels in NaOH scrubbing liquors used in optical fibre manufacture, see Section 2.3.5.

Selection of raw materials

2.2.2 Waste minimisation audit (minimising the use of raw materials)

Principles

The Regulations require the Regulator, in setting Permit conditions, to take account of certain general principles including that the installation in question should be operated in such a way that "waste production is avoided in accordance with Council Directive 75/442/EEC on waste"; and where waste is produced it is recovered, or where this is technically or economically impossible it is disposed of, while avoiding or reducing the impact on the environment. Waste avoidance (minimisation) and the use of clean technologies is covered throughout Section 2.3 and waste recovery and disposal in Section 2.6. While recovery and re-use of raw materials is to be encouraged in all stages of the process it is particularly recommended that operators examine the feasibility of recycling as much cullet as possible.

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".*

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

In the context of waste minimisation and this Guidance, *waste* relates to the inefficient use of raw materials and other substances at an installation. A consequence of waste minimisation will be the reduction of gaseous, liquid and solid emissions.

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.

For the primary inputs to waste activities e.g. the waste to landfill, the requirements of this section may have been met "upstream" of the installation. However, there may still be ***arisings*** that are relevant.

See Reference 8 for detailed information, guides and case studies on waste minimisation techniques.

Application form
Question 2.2 (part 2)

Identify the raw and auxiliary materials, other substances and water that you propose to use.

With the Application the Operator should:

1. Identify, from a knowledge of the plant, the main opportunities for waste minimisation, and supply information on waste minimisation audits and exercises as well as any improvements made or planned.

Indicative BAT requirements

BAT for waste minimisation

1. A regular waste minimisation audit should be carried out. Where one has not been conducted recently, an initial comprehensive audit should be carried out at the earliest opportunity within the improvement programme. New plants will need to have been operating for some time before an audit will be meaningful. Further audits should be at least as frequent as the IPPC Permit reviews. The audit should be carried out as follows:

   The Operator should analyse the use of raw materials, assess the opportunities for reductions and provide an action plan for improvements using the following three essential steps:

   i) process mapping;
   ii) raw materials mass balance;
   iii) action plan.

   The use and fate of raw materials and other materials, including reactants, intermediates, by-products, solvents and other support materials, such as inerting agents, fuels, catalysts and abatement agents, should be mapped onto a process flow diagram (see Reference 8). This should be achieved by using data from the raw materials inventory (see Section 2.2.1) 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.

   Using this information, opportunities for improved efficiency, changes in process and waste reduction should be generated and assessed. An action plan should then be prepared for the implementing improvements to a timescale approved by the Regulator.

Water use

2.2.3 Water use

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.

Reasons for reducing water use

Reducing water use may be a valid environmental (or economic) aim in itself, perhaps because of local supply constraints. In addition, 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 reduction of 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 will reveal where reductions can be made.

Advice on cost-effective measures for minimising water can be found in Environmental Technology Best Practices Programme (ETBPP) publications (see Reference □).

The Glass Industry as a whole is not a major consumer of water, the main uses being cooling, cleaning and batch humidification. Some sectors use water for other purposes, which are discussed further below. Where practicable water circuits are closed loops with make up of evaporative losses. Water can be taken either from the mains supply or from natural sources.

Table 2-1: UK water use benchmark for the production of glass fibre

Sector	Average range
Production of glass fibre	10 – 20 m^3/tonne processed

Continuous filament glass fibre

Water is used for cooling, cleaning, coating preparation and in some cases for wet scrubbing systems. One of the main characteristics of the manufacture of glass fibres, is the need for a large amount of water for cooling. Each bushing needs water to reduce the temperature of the filament very quickly from 1250 °C to ambient temperature. This cooling is achieved by transferring heat to metallic bars close to the bushing tips, and cooling by circulating water, passing cold air through the filaments, and by water sprays. Cooling water is also required around the furnace and the forehearths. Cooling water is generally in semi-closed circuits and total flows are typically several thousands of m^3/h.

Significant amounts of water are also used in coating preparation and wash down in the forming/winding area. The total water consumption per tonne of finished product is typically between 4 and 20 m^3, cooling system losses account for around 20% of this figure.

Mineral wool

Water can be used in the production process for cooling, cleaning, and for binder dilution and dispersion, though the extent and methods of use depend upon the manufacturing technique. The basic processes are net users of water with the potential for release of water vapour and droplets from the forming and curing areas. Also the cullet quench system for glass wool processes will result in water evaporation. Most installations operate a closed loop process water system with a high level of recycling. Water is brought into the process water system from the mains supply or naturals sources. Some water is also brought in with raw materials, particularly binder raw materials. The overall water consumption for mineral wool manufacture is 3 to 10 m^3 /tonne of product for glass wool; and 0.8 to 10 m^3 /tonne of product for stone wool.

Ceramic fibre

The main uses of water in the Ceramic Fibre Sector are for cooling circuits and cleaning. Cooling water is used, usually in closed circuits, to cool various equipment, with corresponding losses from evaporation and purges. Water is also used in vacuum forming operations and for boards and papers. Actual water consumption and water vapour emissions may vary according to local conditions (for example, ambient temperature and the hardness of water input).

Water use

Frit

Water is used for cooling and cleaning purposes, but also for cooling and shattering the molten glass (quenching) and for wet milling. All of the water circuits are usually closed circuits with corresponding losses from evaporation and purges. Other water losses are the water content of the product and the water content of the solids collected from the quench water circuit. Water consumption is estimated at 0.5 - 1.5 m^3/tonne of frit.

Optical fibre

There is no significant use of water in the process itself. However, water is required where wet scrubbers are used to control chlorine and acid gas releases.

Application form Question 2.2 (part 3)

Identify the raw and auxiliary materials, other substances and water that you propose to use.

With the Application the Operator should:

1. Supply information on water consumption and comparison with any available benchmarks.
2. Include a diagram of the water circuits with indicative flows.
3. Describe the current or proposed position with regard to the techniques below, any in the existing Sector Guidance, or any others that are pertinent to the installation.
4. Demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the *A1 Guide for Applicants*) or alternative measures.
5. Describe, in particular, any water audits already conducted and the improvements made or planned.

Indicative BAT requirements

BAT for water efficiency

1. A regular review of water use (water efficiency audit) should be carried out. Where one has not been conducted recently, an initial comprehensive audit should be carried out at the earliest opportunity within the improvement programme. New plants will need to have been operating for some time before an audit will be meaningful. Further audits should be at least as frequent as the IPPC Permit reviews. The audit should be carried out as follows:
   - The Operator should produce flow diagrams and water mass balances for the activities.
   - Water-efficiency objectives should be established by comparison with sector guidance or, where not available, national benchmarks (see Reference 10). In justifying any departures from these (see Section 1.2), or where benchmarks are not available, the techniques described below and those in the existing sector guidance should be taken into account. The constraints on reducing water use beyond a certain level should be identified by each Operator, as this is usually installation-specific.
   - Water pinch techniques should be used in the more complex situations, particularly on chemical plant, to identify the opportunities for maximising reuse and minimising use of water (see ETBPP publications, Reference □).
   - Using this information, opportunities for reducing water use should be generated and assessed. An action plan should then be prepared implementing improvements to a timescale approved by the Regulator.
2. The following general principles should be applied in sequence to reduce emissions to water:
   - water-efficient techniques should be used at source where possible;
   - water should be recycled within the process from which it issues, by treating it first if necessary. Where this is not practicable, it should be recycled to another part of the process that has a lower water-quality requirement;
   - in particular, uncontaminated roof and surface water, which cannot be used, should be discharged separately.

Cont.

Water use

BAT (cont)

3. Measures should be implemented to minimise contamination risk of process or surface water (see Section 2.3.9).

4. To identify the scope for substituting water from recycled sources, the water-quality requirements associated with each use should be identified. Less contaminated water streams, such as cooling waters, should be kept separate where there is scope for reuse, possibly after some form of treatment.

5. Ultimately wastewater will need some form of treatment (see Section 2.3.7). However in many applications, the best conventional effluent treatment produces a good water quality that may be usable in the process directly or when mixed with fresh water. While treated effluent quality can vary, it can be recycled selectively, when the quality is adequate, reverting to discharge when the quality falls below that which the system can tolerate. The Operator should identify where treated water from the effluent treatment plant could be used and justify where it is not.

   In particular, the cost of membrane technology continues to reduce. They can be applied to individual process streams or to the final effluent from the effluent treatment plant. Ultimately, they could completely replace the ETP plant, leading to greatly reduced effluent volume. There remains, however, a concentrated effluent stream but, where this is sufficiently small, and particularly where waste heat is available for further treatment by evaporation a zero effluent system could be produced. Where appropriate, the Operator should assess the costs and benefits of providing such treatment.

6. Water used in cleaning and washing down should be minimised by:
   - vacuuming, scraping or mopping in preference to hosing down;
   - evaluating the scope for reusing wash water;
   - trigger controls on all hoses, hand lances and washing equipment.

BREF sections 4.5.6.1.2 and 4.5.6.1.3

7. The following two points are applicable to the Mineral Wool sector, and any other process where wet scrubbers and/or wet EPs are used:
   - process water with 100% recycling to the process water system should be used as the scrubbing medium for wet scrubbers. A clean water top-up will help to optimise the performance of the scrubber;
   - clean water used in wet EPs (to ensure saturation and to clean the electrodes) should, where practicable, be discharged to the process water circuit as top up.

2.3 Main activities and abatement

(includes "directly associated activities" in accordance with the PPC Regulations.)

Application form Question 2.3

Describe the proposed installation activities and the proposed techniques and measures to prevent and reduce waste arisings and emissions of substances and heat (including during periods of start-up or shut-down, momentary stoppage, leak or malfunction).

With the Application the Operator should:

1. Provide adequate *process descriptions* of the activities and the abatement and control equipment for all of the activities such that the Regulator can understand the process in sufficient detail to assess the Operator's proposals and, in particular, to assess opportunities for further improvements. This should include:
   - process flow sheet diagrams (schematics);
   - diagrams of the main plant items where they have environmental relevance; for example, abatement plant design and the like;
   - details of any chemical reactions and their reaction kinetics/energy balance;
   - control system philosophy and how the control system incorporates environmental monitoring information;
   - annual production, mass and energy balance information;
   - venting and emergency relief provisions;
   - summary of extant operating and maintenance procedures;
   - a description of how protection is provided during abnormal operating conditions such as momentary stoppages, start-up and shut-down for as long as is necessary to ensure compliance with release limits in Permits;
   - additionally, for some applications it may be appropriate to supply piping and instrumentation diagrams for systems containing potentially polluting substances.

   If there is uncertainty, the degree of detail required should be established in pre-application discussions.

2. Describe the current or proposed position for all of the listed requirements for each subsection of 2.3, or any others pertinent to the installation;

3. Identify shortfalls in the above information that the Operator believes require longer-term studies to establish.

4. Demonstrate that the proposals are BAT by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the *Guide for Applicants*) or alternative measures;

In assessing the integrated impacts of proposals and balancing the impacts of different techniques, it should be noted that energy should be taken into account whether or not there is a Climate Change Agreement or Trading Agreement in place (see Section 2.7.3).

Indicative BAT Requirements

See each subsection of this Section 2.3.

Summary of the activities

Emissions can vary greatly between sectors and between individual installations. The main factors are: inherent differences in the raw materials and products for each sector; the process selection (particularly the melter option); the process scale; and the degree of abatement implemented. When considering the emissions from different sectors and installations it is important to consider, in addition to the emission concentrations, the overall amount of any substance emitted and the mass emitted per tonne of product or melt.

The core process outputs can be divided into five main categories: product, emissions to air, liquid waste streams, solid process residues, and energy. Liquid and solid waste streams can be recycled or disposed of, depending on process specific issues. In general, glass installations do not have significant co-product or by-product streams. However, it is becoming increasingly common for material that would otherwise be disposed of as a waste stream to be converted into a saleable (or no cost) form, for use as either a feedstock for other processes or as an end product

In general, glass making involves the melting of a significant mass of materials such as metal oxides, carbonates, sulphates and nitrates. On melting these substances decompose and release gases such as carbon dioxide, water vapour, and oxides of sulphur and nitrogen. The batch materials may also contain moisture (between 0 and 4%, either physically or chemically incorporated), and as the material is heated water vapour is released. In general, between 3% and 20% of the batch weight may be emitted as gases. Where high levels of cullet are used the figure will be at the lower end of this range. (1 tonne of cullet replaces approximately 1.2 tonnes of virgin raw material.)

Other outputs from the processes can include noise and odours. Noise arises from a range of activities including: fans, motors, material handling; vehicle movements, engineering activities, and compressed air systems. Noise is not considered to be a particular problem in the Glass Industry. However, noise sources clearly exist and could lead to problems with any close residential developments. In general, any problems are readily dealt with by good design and where necessary, noise abatement techniques. Certain pollution control techniques can also require noise control, which can add to the overall cost of the technique. Odours are not generally a problem within the Glass Industry, but they can arise from certain activities and measures may be required to avoid problems off-site. The main activities that can be associated with odour problems are mineral wool curing (see Section 2.3.2, cullet preheating and sometimes oil storage.

Raw materials

All of the sectors within the Glass Industry involve the use of powdered, granular or dusty raw materials. The storage and handling of these materials represents a significant potential for dust emissions. The movement of materials through systems incorporating silos and blending vessels results in the displacement of air, which if uncontrolled could contain very high dust concentrations. This is particularly true if pneumatic transfer systems are used. The transfer of materials using conveyor systems and manual handling can also result in significant dust emissions.

Many processes in the Glass Industry involve the use of cullet (either internal or external) which may require sorting and crushing prior to use in the furnace. Like all similar processes this has the potential for dust emissions. The level of emissions will depend on factors such as the design of the facility, if extraction is filtered before discharge, how well buildings are sealed and the like. Some processes also involve the use of volatile liquids, which can result in releases to air from tank breathing losses and from the displacement of vapour during liquid transfers.

Melting

For many of the processes falling within the scope of this document the greatest potential for environmental pollution arises from the melting activities.

Where 100% electrical heating is used the emissions of combustion products and thermally generated NOx are eliminated, and particulate emissions arise principally from batch carry over. The partial substitution of fossil fuel firing with electrical heating will reduce direct emissions from the installation, depending on the level of substitution and the particular combustion conditions. Oxy-fuel firing greatly reduces the level of nitrogen in the furnace and so reduces the potential for NOx formation. There are usually off-site emissions associated with the generation of electricity and oxygen, which should be taken into consideration when assessing overall environmental impact.

BREF Table 3.2

The furnaces encountered within the Glass Industry, and within each sector, vary considerably in size, throughput, melting technique, design, age, raw materials utilised, and the abatement techniques applied. Therefore, there is considerable variation in the emissions reported. The main emissions arising from melting activities are summarised in Table 3.2 of the BREF.

Heavy metal and trace element emission concentrations can be significant from some processes, and are generally present in the dust.

Downstream activities

This term is used to describe activities undertaken following melting, for example, forming, annealing, coating, processing, etc. The emissions from downstream activities can vary greatly between the different sectors and are discussed in the sector specific sections. Although many of the sectors share some similar melting techniques the downstream activities tend to be exclusive to each sector. In general, emissions to air can arise from: coating application and/or drying (for example, mineral wool, continuous filament glass fibre); from any activities performed on the materials produced such as cutting, polishing, or secondary processing (for example, mineral wool, ceramic fibre); and from some product forming operations (for example, mineral wool, and ceramic fibre).

Emissions to water

In general, emissions to the water environment are relatively low and there are few major issues that are specific to the Glass Industry. In general water is used mainly for cleaning and cooling and can be readily recycled or treated using standard techniques. Most activities will use some liquids even if only water treatment chemicals and lubricants or fuel oil. All liquid raw materials pose a potential threat to the environment through spillage or containment failure. In many cases basic good practice and design is sufficient to control any potential emissions. Specific issues relating to aqueous emissions are discussed in the sector specific sections.

Solid waste

A characteristic of most of the Glass Industry sectors is that the great majority of internally generated glass waste is recycled back to the furnace. The main exceptions to this are the Continuous Filament Sector and the Ceramic Fibre Sector. The Mineral Wool and Frits Sectors show a wide variation in the amount of waste recycled to the furnace ranging from nothing to almost 100% for some stone wool plants.

Other waste production includes waste from raw material preparation and handling, waste deposits (generally sulphates) in waste gas flues, and waste refractory materials at the end of the life of the furnace. As with all furnace waste every effort is made at the end of a campaign to have the materials recycled. Where this is not possible, the Chromium VI content of the used mag-chrome refractories will be determined to ensure that they are correctly classified and disposed of appropriately. The industry is gradually reducing the amount of chromium containing refractories by development and redesign. Small tonnages of high purity chromic oxide refractories may also be used. They are generally purchased on the basis that at the end of a campaign they will be taken back by the manufacturer for recycling. In some continuous glass filament furnaces large amounts of this material are used.

Energy

See Section 2.7.

Continuous filament glass fibre

2.3.1 Continuous filament glass fibre

The major output mass flow is the product, which may be from 55% to 80% of raw material input. The losses arise through emissions to air, solid residues, and aqueous wastes. The molten glass represents around 80 - 85% of the furnace raw material input. Most of the loss is made up of gaseous emissions particularly CO_2 from the decomposition of carbonates. Waste fibre and drain glass can be between 10 and 30% of process inputs.

BREF section 3.5

Emissions to Air

- The greatest potential environmental emissions are releases to air from the melting activities.
- Dust emissions, predominantly alkali sulphates and borates.
- Emission levels can depend on many factors, including batch composition, abatement techniques utilised, and the age of the furnace.
- Emissions of fluorides are directly related to the use of compounds containing fluorine in the batch. Fluoride is added to optimise surface tension and liquidity properties, to aid fiberisation and minimise filament breakage. The main source of added fluoride is usually fluorspar (CaF_2), significant levels can also be present in china clay (alumina silicate).

Formulations without added fluorine have been developed and, where effective, dust emissions below 50 mg/Nm^3 and HF emissions in the range 10 - 50 mg/Nm^3 have been achieved. The optimisation of these techniques can require modifications to the furnace design and may be most effectively implemented at a furnace rebuild.

The developments in low fluorine and low boron glasses are the result of expensive development work and the technology is closely guarded by the companies that have developed it. Therefore the technique is not available immediately to all Operators.

- Emissions to air from coating applications are usually quite low, due to the general low volatility of the coating materials and the low glass temperatures at the point of application. High airflows in the forming area ensure adequate cooling of the glass and some carry over of droplets or evaporation of organic compounds occurs. The high volume of cooling air means that emission concentrations are generally quite low.
- Coating materials are generally water based and the fibre cakes are often dried in ovens.
- The drying process will give rise to emissions of water vapour and any substances volatile at the drying temperatures. The coatings are chemically bonded to the glass during the drying process and emissions levels are generally relatively low. Coating formulations, and therefore emissions, can vary widely.
- Emissions can also arise from secondary processing to produce mats and tissues, which involve the use of binders which must be cured or dried. There is a wide variation depending on the techniques and substances used.

Emissions to water

- Emissions arise mainly from the forming area, and also binder preparation, cleaning, cooling, tissue/mat binder application, and from water based scrubbing systems.
- Forming area emissions consist of :
  - Excess binder;
  - Washing water (from periodic cleaning of forming and winding area);
  - Water sprayed on the filaments.
- Emissions can arise in the binder preparation area from spillages and leaks, which drain to the waste water system.
- The high volume cooling water systems require a purge stream, which will contain low levels of water treatment chemicals.
- Most scrubbing systems in use are recirculating water scrubbers, which require either a purge stream or periodic discharge and replacement of the scrubbing medium.
- The total water consumption per tonne of finished product is typically 4 to 20 m^3, cooling system losses (purge and evaporation) account for around 20% of this figure. With the clear exception of evaporative losses most of this water is discharged as wastewater. General practice is to discharge to a sewage treatment works or to treat on-site.

The wastewater pollutant concentrations are usually very low (less than 0.2% solid content before any treatment), due to the dilution by wash down water, and their content is mostly biodegradable. The chemicals used do not contain any heavy metals, or dangerous listed substances. Actual composition varies widely from site to site, due to the great variety of binder compositions. For some products a chrome based coupling agent is still used, but this is being gradually phased out.

Continuous filament glass fibre

Solid waste

Solid waste arises from:

- Batch plant - reject batches, spillages or leakage. The process is very sensitive to raw material quality and in general such wastes are sent to landfill (5 to 50 tonnes per year).
- Drain glass (typically 1-5% of melted glass) containing denser, unmelted particles, from drain bushings prior to the forehearths. Can be processed into cullet and either recycled internally or used in other applications. Internal recycling can cause gradual build up of unmeltable material in the furnace and higher levels of drain glass.
- Waste glass and fibre due to product change over, package change over, and filament breakage, when the glass is still flowing but cannot be converted into saleable product. Waste glass can be one of the main waste streams from the process (10 and 25% of the total molten glass from the furnace, depending on the type of forming process and on the diameter of the filaments). The waste fibre contains up to 25% water and dilute binder.
- Conversion of cake to finished product - from the inside and outside of the cakes, fuzz, damaged and reject material, test samples, mat trimmings, etc (3-10% of finished product). Contains coating material at a level from 0.5 to 10% (up to 20% for tissues), and may contain water up to 15%.
- Dust collected in abatement equipment can be recycled to the furnace. If dry scrubbing techniques are incorporated this may be more difficult requiring blending or processing.

Energy

- Energy usage can vary depending on the size of the melter and the type of downstream processes. >75% used for melting; around 15% forming (including bushing heating, and product conversion); the remainder for services, control systems, lighting, and factory heating.
- Most furnaces in this sector are gas fired recuperative furnaces some with electric boost (up to 20% of melting energy).
- There are also examples of oil fired furnaces, oxygen enriched firing and some oxy-gas furnaces.
- The air preheat temperature of recuperative furnaces is lower than that of regenerative furnaces and the energy requirements are consequently higher per tonne of glass.
- The electrical conductivity of the glass is very low, and currently 100% electric melting is not considered economically or technically viable.
- The energy consumption of the process will depend on many factors, the main ones are outlined in Section 3.2.3 of the BREF. Energy consumption for melting is typically 11 to 23 GJ/tonne of melt, although for some small furnaces producing specialised compositions this can be up to 30 GJ/tonne. Overall energy consumption is usually in the range 18 to 33 GJ/tonne of product. Maximum crown temperatures in continuous filament glass fibre furnaces are typically around 1650 °C, (for example, up to 250 °C higher than glass wool).

Application form
Question 2.3 (cont.)

Continuous filament glass fibre

With the Application the Operator should:

1. Supply the general application requirements for section 2.3 listed on page 38 for this aspect of the activities.

BAT for continuous filament glass fibre

Indicative BAT requirements:

Melting:

1. For dust abatement, BAT is considered to be an Electrostatic Precipitator (EP) or bag filter with dry or semi-dry acid gas scrubbing. The Operator should provide full justification where other techniques are used. See Section 2.3.6.
2. Due to the nature of the dust, abatement efficiency must be optimised by ensuring waste gases are adequately cooled and abatement equipment is positioned correctly in the process. See Section 2.3.6.
3. When bag filters are used, a very high level of maintenance is required to avoid frequent by-passing of the abatement equipment (due to bag blinding) and the replacement of expensive bags.

Cont.

Continuous filament glass fibre

4. BAT for releases of oxides of nitrogen (expressed as NO_2) is oxy-fuel firing, which can be fitted during a furnace re-build. The Operator should justify the use of other techniques to control NOx. See Section 2.3.6.

5. BAT for releases of oxides of sulphur (as SO_2) is secondary dust abatement with dry or semi-dry acid gas scrubbing. See Section 2.3.6.

6. For other emissions, chlorides and metals, BAT is considered to be primary measures or acid gas scrubbing combined with dust abatement.

BREF sections 4.4.4.1 and 4.5.3

7. Fluoride additions to the batch should be minimised wherever possible by:
   - Development and use of non-fluorine batch formulation;
   - Using appropriate substitute materials in the batch;
   - Where use of added fluoride is justified, abatement by dry or semi-dry scrubbing combined with dust abatement and recycling of the collected material back to the furnace should be utilised;
   - A site-specific BAT assessment may be required.

8. Every effort should be made to develop glass compositions containing no more than trace levels of boron.

Downstream operations:

9. Emissions associated with downstream processing can be very variable and a range of primary and secondary techniques can be used to meet emission levels. Site specific BAT assessments should be carried out.

10. Coating materials with low levels of organic solvents should be used to reduce emissions

11. Coating formulations should be optimised to minimise releases of VOC during the ***drying*** process and any subsequent secondary processing.

12. Dust emissions from any downstream process (for example, cutting, milling) should be controlled by extraction to a filter system.

2.3.2 Mineral wool

The major output mass flow is the product, which may be from 55% to 85% of material input, for stone wool processes, and 75% to 95% for glass wool processes. An important factor in this is the recycling of process residues, which significantly increases the efficiency of raw material utilisation. The losses arise through solid residues, aqueous wastes and emissions to air.

BREF section 3.8

Emissions to air

- Glass wool raw material batches tend to be dry and pneumatically conveyed. Therefore, the potential for dust emissions from raw material handling may be higher than in some other sectors.
- Stone wool processes generally use coarse raw materials with particle diameters >50mm. The materials are stored in silos or bays and are handled using manual systems and conveyors. There is potential for wind borne dust during storage and handling particularly during dry weather.
- Releases from glass wool furnaces will consist of SO_2 , CO_2, NOx, particulate matter and some levels of chlorides and fluorides.
- Stone wool cupola furnaces operate under strong reducing conditions. Emissions are:
  - NOx (relatively low);
  - H_2S (sulphur in fuel or raw materials being reduced. Will be oxidised to SO_2 if an afterburner is installed);
  - CO (will be oxidised to CO_2 if an afterburner is installed);
  - The coke and raw materials may contain higher levels of metals, chlorides and fluorides (compared to some other glass processes) giving rise to higher emissions;
- An increasingly important factor affecting melter emissions is the contribution from recycled materials. If fibre containing binder is recycled to the furnace the organic component must be considered. In cupolas this is not a problem, but in glass furnaces it may be necessary to add oxidising agents such as potassium nitrate, which may have the effect of increasing NOx emissions.
- In stone wool processes cement is often used for briquetting of process residues, and when the briquettes are melted there are consequent emissions of SO_2.
- The forming area waste gas will contain particulate matter (organic and inorganic material, often small particle size), phenol, formaldehyde and ammonia, derived from the phenolic resin based binder. Lower levels of VOCs and amines may also be present if included in the binder system. This gas stream has a high volume and high moisture content.
- Releases from the curing oven consist of volatile binder materials, binder breakdown products, water vapour and combustion products from the oven burners. Glass wool products generally contain relatively higher binder levels than stone wool products resulting in higher emissions. Oven emissions also tend to be odorous if not treated.
- Curing ovens are usually gas fired. Oven emissions are sticky and represent a potential fire risk due to the deposition of combustible material in the extraction system, particularly in glass wool ovens. To prevent fires the gas stream must either be water scrubbed or additional heat provided to destroy the sticky nature of the pollutants. In processes without incineration, water is usually sprayed into the extraction ducting to prevent the build up of resinous material, and to prevent fires.
- Cooling air contains mineral wool fibre and low levels of organic fume, which may be odorous. This gas stream is not a major issue within the sector but it can cause local problems.
- Product finishing can give rise to dust emissions.
- Higher binder content products will generally result in higher emission levels from forming, curing and cooling.

Emissions to water

Under normal operations the processes are net consumers of water and aqueous emissions are very low.

- Most processes operate a closed loop process water system, and where practicable cooling water blow down and cleaning waters are fed into that system. If they are incompatible or if the volumes are too great they may have to be discharged separately, or a holding tank used to accommodate volume overloads, which can then be bled back into the system.
- Clean warmed cooling water can be discharged to sewer or a natural watercourse.
- Small amounts of contaminated wastewater may arise from chemical bunds, spillages and oil interceptors and the like.
- The process water system causes a potential for contamination of clean water circuits such as surface water and cullet quench water.

- Wet scrubbing liquor (particularly chemical scrubbing) – if effluent is not compatible with process water system, disposal will be required.

Solid waste

The main sources of solid waste are:

- Spillages from batch raw materials handling.
- Process cullet produced by quenching hot melt in water during fiberising machine by-pass in glass wool production.
- Unfiberised melt from stone wool processes during fiberising machine by-pass.
- Dust collected from abatement systems, mainly electrostatic precipitators and bag filters.
- Shot from stone wool fiberising. This is heavy non-fibrous and semi-fiberised material that is too heavy to reach the collection belt, and is collected below the fiberising machine. Around 10 to 20% of the melt hitting the fiberising machine forms shot.
- Product edge trims.
- Waste wool created during product changeovers, line stoppages or out of specification products.
- Waste from stone wool filters, which has a high organic content, often around 50%.
- Iron and melt from stone wool cupola tap outs.
- Mixed melt and stone from cupola shut down.
- Solid waste from process water circuit filtration. This represents 0.5 to 2.0% of process throughput and consists of fibre, binder solids and up to 50% moisture.
- Packaging waste and other general waste.
- Refractory waste from furnace rebuilding.

In glass wool production it is common to recycle directly to the furnace, batch spillages, glass wool cullet and dust collected from abatement systems.

In stone wool processes shot, by-pass melt, abatement system dust and fibrous waste is generally recycled if a briquetting process is in use. Edge trims are usually shredded and recycled to the forming area. Dry waste product can be shredded to produce a blowing wool product.

Cupola shut down and tap out waste can theoretically be recycled through a briquetting system, but this is not common, because it is inert and can be used as filling material (for example, road fill). It is also possible to separate the metallic iron from the waste and sell it as scrap iron, but there is little financial incentive to do this.

Energy

The predominant energy sources for glass wool melting are natural gas and electricity.

- Stone wool is predominantly produced in cupolas which are fuelled by coke, and there are some examples of gas fired and electrically heated furnaces.
- Natural gas is also used in substantial quantities for fiberising and curing.
- Electricity is used for general services and light fuel oil, propane and butane are sometimes used as back up fuels. There are a number of oxy-gas fired furnaces in the sector.

The three main areas of energy consumption are melting, fiberising and curing. The split can vary greatly between processes and is very commercially sensitive. The BREF provides more detail of energy consumption in mineral wool production, with a breakdown into the main process areas.

Direct energy consumption for electrical melting is in the range 3.0 to 5.5 GJ/tonne of finished product. Energy consumption for electrical melting is approximately one third of that required for 100% air-gas melting.

Odour

Emissions of odour can arise from:

- Cold top electric melters where mineral wool waste is being recycled;
- Partial thermal breakdown of binder materials during melting (minimised by adding oxidising agents or pretreating the fibre);
- H_2S from cupola melting;
- Forming and curing processes (main sources of odour) – from chemical and thermal reactions of the organic binder;
- Product cooling, particularly dense or high binder products, or where over curing has occurred.

Refer to Section 2.3.10 for odour control measures.

Mineral wool

Application form Question 2.3 (cont.)

Mineral wool

With the Application the Operator should:

1. Supply the general application requirements for section 2.3 listed on page 38 for this aspect of the activities.

BREF section 4.5.6.1.1

Glass wool (only):

2. Provide details of all in duct water sprays used (in the extraction ducting and into the fan).

Stone wool (only):

3. Carry out a sulphur balance calculation to determine appropriate emission levels for oxides of sulphur (as SO_2), taking into account all sources of sulphur oxides, such as recycling of process wastes, use of cement bound briquettes etc.

BREF sections 4.4.3.2 and 4.5.6.1.4

4. Carry out a site-specific assessment of the impact of slag usage on the pollution of the environment as a whole. This should include an assessment of the merits of increased utilisation of recycled process waste in place of the slag.

5. Describe investigations undertaken, and the results of such work, to minimise the cement content of briquettes or replace it completely with other binder systems.

6. The Operator should demonstrate that operational procedures can detect when the efficiency of a *stone wool filter* is declining and ensures that filters are changed when necessary.

BAT for mineral wool

General indicative BAT requirements (applicable to both glass and stone wool processes):

7. In general, BAT for dust releases from *melting operations* is considered to be an Electrostatic Precipitator or bag filter. In glass wool production, the use of dry or semi-dry acid gas scrubbing is not generally necessary to protect the other abatement equipment where furnaces are gas fired or electrically heated. Hot blast cupolas will normally be fitted with bag filters rather than EPs due to the risk of explosion.

BREF sections 4.5.6.1 to 4.5.6.4

8. Emissions of halides and metals from *melting operations* should be controlled by raw material selection. See Section 2.2.1.

9. Optimisation of the following should be carried out to reduce process emissions:
   - Binder system chemistry;
   - Fiberising technique;
   - Operating conditions (temperature, airflow and moisture);
   - Level of binder applied; and
   - The method of binder application.

10. For controlling releases of dust from the *forming area* and where emissions from the *forming and curing areas* are combined, BAT is the use of either a wet Electrostatic Precipitator (EP), a packed bed scrubber, or a stone wool filter (for stone wool processes only), following optimisation of primary measures.

11. Urea usage in the binder should be maximised to reduce the releases of formaldehyde, and as a replacement for phenol.

12. For *curing oven* emissions, BAT for glass wool processes is either a wet EP or packed bed scrubber. For stone wool processes, thermal incineration should be used. This technique may not be applicable where high-density products or products with high binder contents are produced.

13. The three main options for treating *cooling area* emissions are:
   - A filter system to remove dust combined with a sufficient discharge velocity and height to avoid ground level odours;

Cont.

- A wet scrubbing system combined with adequate dispersion. A venturi type system would give the lowest particulate and fume emissions;
- Combination of the cooling air with the forming area or the curing oven waste gas treatment system.

The combination option is the favoured option (environmentally and economically) although any of the three are acceptable where justified according to the local circumstances.

14. The dust emissions resulting from *product machining and packaging* activities should be efficiently extracted and passed through a fabric filter. Procedures should ensure that extracted air volumes are reduced to a minimum commensurate with good dust collection, that is:
    - Bag failure detection by continuous monitoring of particulate concentrations;
    - Have alarmed pressure drop monitors;
    - Be a negative pressure system;
    - Have optimised cleaning cycles to ensure maximum filtration efficiency.

BAT requirements for glass wool processes (only):

15. When bag filters are used, a very high level of maintenance is required to avoid frequent by-passing of the abatement equipment (due to bag blinding) and the replacement of expensive bags.

16. For emissions of oxides of nitrogen (expressed as NO_2) from *melting operations*, BAT is oxy-fuel firing or electrical melting. The use of other techniques may be acceptable providing that the Operator can demonstrate that emission levels are consistently achieved.

17. Where significant quantities of nitrates are required in the batch (for example, for recycling materials with a high organic component) secondary abatement or conversion to oxy-fuel melting or electrical melting may be required.

18. Where furnaces are gas fired or electrically heated, emissions of oxides of sulphur (expressed as SO_2) are generally low. If furnaces are oil fired, BAT is acid gas scrubbing, to protect the dust abatement equipment.

19. Emissions from the forming and curing areas should be combined and treated as a single waste stream when practicable.

BREF sections 4.5.6.1.1 and 4.5.6.1.3

20. In duct water sprays (impact jets) should be used to prevent material build up in the extraction ducting and to help remove particulate and gaseous components from the gas stream.

21. The design of impact jets should optimise the efficiency of the technique for both duct cleaning and waste gas scrubbing.

22. Cyclones, or an equivalent alternative, should normally be used with impact jets to remove entrained water, in order to reduce water consumption and to achieve acceptable levels of plume visibility and dispersion.

23. Exhaust gases from wet Electrostatic Precipitators (EP) must be well distributed at the entrance to the EP to produce a uniform and low gas velocity between all elements. Clean water should be used to ensure saturation, sprayed at the entrance to the EP, and to clean the electrodes. Where practicable, this water should be discharged to the process water circuit to prevent the formation of an additional aqueous waste stream.

BAT requirements for stone wool processes (only):

BREF sections 4.4.3.1 to 4.4.3.3, 4.4.5 and 4.5.6.1.4

24. Fuel selection: - In hot blast cupolas, sulphur content of the coke should be less than 1%. High sulphur fuels, for example petcoke, should not be used.

25. For each installation, a sulphur balance is required to determine appropriate emission levels of oxides of sulphur (as SO_2) commensurate with the BAT.

26. Where blast furnace slag is used is required for product or process reasons, dry scrubbing is required to control emissions of sulphur oxides.

Cont.

Mineral wool

27. Stone wool cupolas should be fitted with an afterburner to oxidise emissions of carbon monoxide before release. This will also oxidise emissions of hydrogen sulphide where levels are not controlled by raw materials selection.

28. SOx reduction must take place following the incinerator and before the filter system. In some current applications the filter system is positioned prior to the incinerator, which is designed to treat a clean gas. In these cases, the installation of the technique on existing plants will require modifications to the incinerator or a second filter system.

29. The filter medium for Stone wool filters (used in the *forming area*) should be changed at regular intervals in order to maintain particulate removal efficiency. The used filter slabs should be recycled to the furnace. Overall efficiency of the process is maximised if carried out under dry conditions.

30. The technique should be employed in conjunction with primary controls (for example, dry operation) and a low aerosol emission to minimise levels of gaseous emissions and maintain a very low visibility plume.

31. Thermal incineration should be used to control *curing oven* emissions. The main requirements for effective combustion are:
    - Residence time of 1 - 4 seconds in the combustion chamber to ensure complete combustion;
    - Operating temperature 200 - 400 °C above the auto-ignition temperature of the most stable substance (that is operating temperature around 800 °C). Where the gas stream contains chlorinated and aromatic substances, temperatures must be increased to 1100 - 1200 °C, and rapid flue gas cooling is required to prevent the formation of dioxins;
    - Turbulence is necessary to provide efficient heat and mass transfer in the combustion zone, and to prevent "cool" spots.

32. Where incineration is not installed, the following techniques should be optimised to control releases:
    - Recirculation of gases within the oven;
    - Using the oven waste gas as combustion air for the oven burners.

Ceramic fibre

2.3.3 Ceramic fibre

The yield from raw materials to melt is generally greater than 90% and the yield from melt to finished product (blanket/bulk) is estimated at 55% to 85%. This may vary according to the type, nature, volume and duration of the production.

BREF section 3.9

Emissions to air

- Emissions from melting are generally very low consisting mainly of dust from raw materials. The raw materials are usually very pure and consist almost exclusively of oxides; therefore there is little degassing and no significant emissions of gaseous compounds.
- Dust and fibre releases can be generated from a number of areas within the process, these include: fiberisation and collection, needling, lubricant burn off, slitting, trimming, cutting, packaging, and areas of secondary processing.
- Organic emissions may also occur from some secondary processing activities, especially from drying and curing operations.

Emissions to water

- The main uses of water in this sector are cleaning, cooling, and for vacuum forming and other secondary processing.
- The aqueous emissions are limited to the cooling water system purges (containing dissolved salts and water treatment chemicals), cleaning waters (inert solids and oils) and surface water run off (quality depends on the degree of drainage segregation and site cleanliness). Water used for vacuum forming is recycled with a purge, which may contain low levels of organic substances.

Solid waste

- Waste levels are generally low.
- Wherever possible waste materials (batch, cullet, edge trims and the like) are recycled either directly to the furnace (requires processing for fibres) or into the products.
- Waste material from the dust abatement equipment. This material is generally not recycled directly to the furnace due to potential contamination and uncertainty over composition.

Most mineral raw materials are delivered in bulk and do not give rise to packaging waste. Waste materials from product packaging operations are usually reused or recycled if practicable. Other waste non-specific to the industry is disposed of by conventional means, or recycled. At the end of a furnace campaign, the refractory structure is dismantled and replaced. Where practicable this material is recovered for reuse or sale.

Energy

There is little information available on energy use within this sector.

- Melting is exclusively electrically heated with very low volatile losses. Therefore, the direct melting efficiency (excluding off-site issues) is quite high, although the composition has a high melting energy requirement and the furnaces are relatively small.
- Energy consumption ranges from 6.5 -16.5 GJ/tonne of melt. The energy consumption for the other activities ranges from 3.5 - 9.5 GJ/tonne product (based on 75% conversion raw materials to finished product).

Application form Question 2.3 (cont.) → **Ceramic fibre**

With the Application the Operator should:

1. Supply the general application requirements for section 2.3 listed on page 38 for this aspect of the activities.
2. Provide details of the quantity (percentage of the total) of material collected from filters which is recycled to the furnace.

Cont.

Ceramic fibre

BAT for ceramic fibre

BREF section 4.5.7

Indicative BAT requirements:

1. The principal concern is the release of particulate matter, which may include ceramic fibres. BAT is considered to be electric melting in conjunction with a bag filter system. The most effective filtration system is a primary filter followed by a high efficiency secondary filter fitted with a pressure drop monitor and continuous monitoring of the emissions.

2. Where only primary filters are installed these should be:
   - Well designed and operated efficiently;
   - Bag failure detection by continuous monitoring of particulate concentrations;
   - Have alarmed pressure drop monitors;
   - Be a reduced pressure system;
   - Have optimised cleaning cycles to ensure maximum filtration efficiency.
   - Written procedures, which specify the actions to be taken in the event of an alarm, should be agreed with the Regulator. These procedures should specify the criteria requiring process shut-down and should cover the mechanism for safe shut-down.

3. The collected material must be handled and disposed of in a manner that prevents any release to atmosphere or water. The Operator should consider whether the collected material can be recycled to the process.

4. Where organic releases are >100g per hour, they should be controlled by primary formulation measures (that is use of low VOC binder formulations) or by incineration or absorption.

5. BAT for all downstream processing areas where dust may arise is collection and extraction to a bag filter system. See Section 2.3.6.

2.3.4 Frits

BREF section 3.10

The melt yield from raw materials is 75 - 80% depending on the precise formulation. Most of this loss is made up of CO_2 emitted during melting. The basic product yield from melt is very high because the material is simply quenched, the only losses are solids that cannot be separated from the water. Cullet is not produced as such.

Emissions to air

The greatest potential environmental emissions are releases to air from the melting activities.

- Dust emissions depend on whether abatement is fitted.
- Oxides of nitrogen emissions depend mainly on the combustion system.
- Levels of emissions of oxides of sulphur depend on the sulphate level of the batch.
- Emissions of fluorides are directly related to the use of fluoride compounds in the batch. Fluorides are predominantly used in the production of enamel frits and are not usually present to any significant extent in the raw materials used in glass frit production. Some glass frit producers may, periodically, manufacture small quantities of enamel frits in the glass frit kilns, giving rise to fluoride emissions. The emission of fluorides is probably the most significant environmental impact of enamel frit production.
- Emissions to air from downstream processes are very low. The vast majority of milling is carried out wet, but dry milling could give rise to dust emissions if not abated.

Emissions to water

- Emissions to water consist of normal cooling, cleaning and surface run off emissions.
- The quenching and milling circuits are usually closed with fresh water top-up but sometimes have a purge to prevent salts build up. Emission levels are very low but may contain suspended solids and in some circumstances heavy metals may be present in the suspended solids. The metals are usually bound in the glass and can be removed by solids separation techniques.

Solid waste

Waste levels are generally very low.

- Sources are most likely from:
  - processing waste (solid material - mainly frit, separated from the water circuits). This material is not usually recycled because the composition is too variable. In most plants the waste to good production ratio will be in the region of 0.5 - 3%;
  - Dust from abatement equipment (recycled to the process);
  - Packaging waste (from product packaging operations). Usually reused or recycled when practicable;
  - Other (non specific) waste is disposed of or recycled;
  - Furnace refractory, at the end of a campaign is dismantled and replaced. Where practicable this material is recovered for reuse or sale.

Energy

There is very little information available on energy use within this sector.

- Furnaces are predominantly (>90%) gas fired although there are some oil fired furnaces and some dual fuel fired furnaces. Oxy gas firing is common. There are no known examples of electrical melting on a commercial scale.
- Furnaces tend to be very small relative to most furnaces in the Glass Industry. There are usually several small furnaces at a particular installation, each producing different formulations.
- Overall energy consumption per tonne of melt is comparable to other sectors, approximately 13 GJ/tonne. Non-melting energy use is very low due to the low level of downstream processing, and products are not usually dried.

Frits

Application form Question 2.3 (cont.)

Frits

With the Application the Operator should:

1. Supply the general application requirements for Section 2.3 listed on page 38 for this aspect of the activities.

2. Supply details of any scrubber system and absorbent used for dust and/or fluoride abatement.

Indicative BAT requirements:

BAT for frits

1. BAT for dust is considered to be the use of an Electrostatic Precipitator or bag filter operating, where appropriate, in conjunction with dry or semi-dry acid gas scrubbing. See Section 2.3.6. The Operator should fully justify the use of other techniques, that is demonstrate that release levels can be consistently achieved by alternative means.

2. For dry or semi-dry scrubbing systems, the choice of absorbent is important to minimise competing reactions and to optimise reductions in emissions of both SO_2 and HF/HCl.

3. Packed bed, wet scrubbing can also be utilised. An aqueous waste stream is generated which must be adequately disposed of, see Section 2.3.7.

4. Where rotary or box furnaces are used, charged from a hopper above the furnace, hopper systems should be designed to minimise charging height to minimise particulate carry over in the waste gas.

BREF sections 4.4.4.1 and 4.4.4.2

5. Fluoride additions to the batch should be minimised wherever possible by:
   - Development and use of non-fluorine containing batch formulations;
   - Using appropriate substitute materials in the batch.

6. Where the use of added fluoride can be justified, abatement by dry or semi-dry scrubbing and recycling of the collected material back to the furnace should be utilised.

7. For releases of oxides of nitrogen (as NO_2), BAT is the use of oxy-fuel melting.

8. For downstream operations, dust should be controlled by extraction and containment in a bag filter system, see Section 2.3.6.

2.3.5 Optical fibre

Emissions to air

- The principal environmental concerns are the releases of particulate matter, acid gases (hydrogen fluoride and hydrogen chloride), and chlorine. The particulate matter consists of silicon dioxide "soot", and has a high proportion of particles with diameters of less than 1 µm.
- Some VOC releases may be generated during the application of the coating material following the drawing process. These releases are generally very minor, and will rarely require specific control measures.

Emissions to water

- There are no significant aqueous releases associated with the production of optical fibre. However, releases are generated where wet scrubbers are used to control chlorine and acid gas releases. Where sodium hydroxide is used in the scrubber liquor, levels of mercury can be an issue and require control.

Solid waste

The main sources of solid waste are:

- Waste fibre – process scrap and finished product scrap/reject.
- Special waste – used oil, waste resins, waste inks, other waste organic solvents used in the process.
- Bag filter waste.
- Waste packaging materials.

Energy

Application form Question 2.3 (cont.) → **Optical fibre**

With the Application the Operator should:

1. Supply the general application requirements for Section 2.3 listed on page 38 for this aspect of the activities.

Indicative BAT requirements

BAT for optical fibre

1. High efficiency bag filters or venturi scrubbers should be used for the fine particulate (diameter <1 µm) and SiO_2 "soot", followed by a wet scrubber.
2. Fabric filter systems should be fitted with failure detection devices and continuous monitoring.
3. The wet scrubber, with or without addition of NaOH to the scrubber liquor, should be used to treat the acid gases and chlorine releases from the process.
4. Mercury levels in NaOH scrubber liquors should be <1ppm.

Abatement to air

2.3.6 Control of point-source emissions to air

Sources

The nature and source of the emissions expected from each activity is given in previous sections and will be confirmed in detail in the Operator's response to Section 3.1. In general they comprise:

- CO_2, water vapour, SOx, and NOx from melting operations;
- particulates and fibre from melting operations and downstream processes;
- HCl, HF and chlorine from optical fibre manufacture;
- phenol, formaldehyde and ammonia from phenolic resin based binders;
- other VOCs from binder preparation and curing/drying processes after binder application

Cross-sectoral guidance on abatement techniques for point-source emissions to air can be found in Reference 11.

Application form Question 2.3 (cont.)

Control of point-source emissions to air

With the Application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 38 for control and abatement equipment; and in addition
2. Describe the measures and procedures in place and proposed to prevent or reduce point source emissions to air. This should include, but is not limited to, the general measures described below. Justify where any of the measures are not employed.
3. Provide the following with the application as appropriate. If there is doubt, the degree of detail required should be established in pre-application discussions:
   - a description of the abatement equipment for the activity;
   - the identification of the main chemical constituents of the emissions (particularly for mixtures of VOCs) and assessment of the fate of these chemicals in the environment;
   - measures to increase the security with which the required performance is delivered;
   - measures to ensure that there is adequate dispersion of the emission(s) to prevent exceedances of local ground level pollution thresholds and limit national and transboundary pollution impacts, based on the most sensitive receptor, be it human health, soil or terrestrial ecosystems;
   - damage to health or soil or terrestrial ecosystems.
4. Demonstrate that an appropriate assessment of vent and chimney heights has been made. Guidance is given in *Technical Guidance Note D1* (Reference 13); and may need to be supported by more detailed dispersion modelling as described in Section 4.1.
5. Where appropriate, also recognise the chimney or vent as an emergency emission point and the likely behaviour. Process upsets or equipment failure giving rise to abnormally high emission levels over short periods should be assessed. Even if the Applicant can demonstrate a very low probability of occurrence, the height of the chimney or vent should nevertheless be set to avoid any significant risk to health. The impact of fugitive emissions can also be assessed in many cases.
6. Most fossil fuel fired furnaces require sensitive pressure control, the presence of a bag filter with a high pressure drop can make this more difficult. Where a bag filter is used in conjunction with a fossil fuel fired furnace the Operator should demonstrate how pressure control of the furnace and bag filter is maintained to ensure optimum operating conditions across the whole system at all times.
7. Demonstrate what control measures are in place to ensure that any volatile species have been condensed before the waste gas is treated or measured.
8. Provide details of all oxidising and fining agents used in the process.
9. Provide details of the measures taken to control the resulting increase in CO_2 emissions when the *'3R' process* is utilised on regenerator furnaces.

BREF sections 4.4.1, 4.4.2.2, 4.4.2.6.1, 4.4.2.8

Cont.

10. Where *Selective Non Catalytic Reduction* is used to control NOx emissions, the Operator should demonstrate that the reagent is introduced at a point in the gas stream where the correct temperature can be maintained for an adequate reaction time. Details of reaction times should be included. Information should also be included to show that adequate mixing occurs.

BREF section 4.4.3.3

11. Where *dry or semi-dry scrubbing* techniques are employed, the Operator should provide details of:
    - The type of process;
    - Amount and type of absorbent added (include the molar ratio between the reactant and pollutants) and how dispersion of the absorbent is achieved;
    - How the choice of absorbent also considers the reduction of emissions of HF and HCl;
    - Waste gas temperatures;
    - Reduction in levels of SO_2 achieved;
    - Details of the recycling or disposal of the resulting solid waste stream, including what proportion of the stream is sent where.

Indicative BAT requirements

1. The Operator should complete any detailed studies required into abatement or control options (see item 3 in Section 2.3) as an improvement condition

2. *Steam plume elimination.* Releases from wet scrubber vents should be hot enough to avoid visible plume formation in the vicinity of the vent. This is to prevent the condensation or adsorption of environmentally harmful substances by the condensing water vapour. Exhaust gases from a wet scrubber can be heated by the use of waste heat to raise the temperature of the exhaust gases and prevent immediate condensation on the exit from the vent. This procedure also aids the thermal buoyancy of the plume. Where there is no available waste heat and the vent contains no significant environmentally harmful substances, the Applicant may be able to demonstrate that the BAT criteria have nonetheless been met.

Particulate Matter

BREF sections 4.4.1

3. Emissions from carry over of batch materials should be minimised by:
    - maintaining a level of moisture in the raw materials;
    - controlling the batch blanket coverage, particle size, gas velocity and burner positioning.

4. Emissions of metals, either within the dust or as gaseous components, should be controlled by:
    - raw material selection to minimise contamination and where practicable to use alternative additives. Raw material selection includes cullet sourcing and sorting;
    - Dust abatement techniques (see Section 2.3.8).
    - For gaseous emissions, use of dry or semi-dry scrubbing techniques in combination with dust abatement (see Section 2.3.8).

5. Raw material modifications – consumption of boron containing materials should be minimised where practicable. Where this is not possible, secondary abatement is required.

6. Furnace crown temperature should be adequately controlled to minimise particulate formation. Reductions of furnace temperature must be balanced with glass quality and the productivity of the furnace. The main points are:
    - Furnace design and geometry;
    - Use of electric boost;
    - Increased use of cullet.

7. Burners should be positioned to optimise combustion air velocity and direction and fuel velocity and direction. Consideration should be given to combining these changes with modifications to furnace width and the length of the unfired portion of the blanket. This should be expected to be included in an agreed improvement programme for implementation at furnace rebuild.

8. Where an acceptable supply of natural gas is available, conversion from fuel oil firing to natural gas firing should be implemented, taking into account the costs of prevailing fuel prices.

Cont.

Abatement to air

9. Emissions from cold top electric melters should be minimised by:
   - Reducing air flows and turbulence during charging;
   - Controlling raw material grain size;
   - Optimising moisture content.

BREF section 4.4.1.2

10. *Electrostatic Precipitators (EPs)* should be controlled by automatic control systems, which ensure optimum high tension (HT) voltage is applied to the electrodes. Fixed HT supplies are unlikely to provide optimum collection efficiencies.

11. Gas flow through the EP unit must be uniform with no bypasses through the electrical field. Uniform flow should be achieved at the inlet to the unit.

12. Operating temperature should be maintained below the particulate formation temperature (approximately 430 °C) to ensure any volatiles present condense, and to achieve EP operating limits. For *Glass wool processes*, which contain significant levels of borate gas, temperatures should be reduced to below 200 °C prior to treatment, whilst ensuring condensation and the associated risk of corrosion in the system is minimised.

13. Where waste gases contain significant levels of acid gases, pre-treatment using acid gas scrubbing should be carried out to prevent corrosion of the EP (*exception*: glass wool processes with gas firing and low sulphur raw materials). Where practicable, the resulting solid material stream should be recycled to the furnace.

BREF section 4.4.1.3

14. *Bag Filters.* The waste gas temperature must be maintained in the correct range for the bag filter system, that is above the dew point of any condensable species present (to prevent condensation and bag blinding) and below the upper temperature limit of the filter medium (to prevent damage).

15. Where waste gases contain significant levels of acid gases, pre-treatment using acid gas scrubbing should be carried out to prevent acid condensation which would damage the bags and the filter housing.

16. Acid gas absorbents, where used, should be chosen to be compatible with the raw materials to enable recycling (with adjustment of the batch composition where necessary).

17. The solid waste stream generated from the process should be recycled to the furnace. This is also applicable where acid gas scrubbing is incorporated with a bag filter.
    - A well developed technical operating procedure combined with a demonstrably reliable continuous electronic control system should be in place to ensure optimised operation at all times and to prevent avoidable damage to the filter fabric. This includes having optimised cleaning cycles to ensure maximum filtration efficiency.

18. A system of bag failure detection should be incorporated, comprising:
    - Bag failure detection by continuous monitoring of particulate concentrations;
    - Alarmed pressure drop monitors;

BREF section 4.4.2

Oxides of nitrogen

The following techniques are recommended to reduce oxides of nitrogen discharged to the atmosphere:

Primary NOx measures:

19. The following combustion modifications should be used to minimise the formation of thermal NOx in the furnace:
    - Reduced air/fuel ratio;
    - Air or fuel staged combustion;
    - Low NOx burners;
    - Choice of fuel.

    These primary measures should be optimised by a demonstrable sustained period of gradual experimentation and monitoring combined with a high degree of technical expertise and experience.

Cont.

Abatement to air

20. Nitrate levels should be reduced, by demonstrable experimentation, to the minimum commensurate with product and melting.

21. *The '3R' process.* For regenerator furnaces, where hydrocarbon fuels are added to the waste gas stream (at the furnace entrance), i.e. the '3R' process, additional measures are required to control CO_2 emissions, e.g. heat recovery.

22. *Selective Catalytic Reduction (SCR).* Where high sulphur fuels (oil or gas) are used, the formation of SO_3 and subsequent reaction to ammonium bisulphate should be controlled, to prevent the catalyst from being poisoned and causing fouling and corrosion of the equipment. Air should be blown through the catalyst bed on a regular basis to prevent blinding and blockages by the remaining fine dust.

23. A dust removal unit is required prior to the SCR unit. Dust levels should be in the region of 10 - 15mg/m^3 prior to entering the SCR unit. Where an EP is used, acid gas scrubbing is also required upstream of the EP.

24. Ammonia levels should be maintained below a ratio of 1.1:1 (NH_3:NOx) to limit the potential for ammonia breakthrough. Ammonia emissions must be controlled and maintained at below 10mg/m^3.

25. *Selective Non catalytic Reduction (SNCR).* The following factors must be controlled to maintain the efficiency of the technique:
    - Temperature;
    - Initial NOx concentration;
    - Uniform reagent and flue gas mixing;
    - Ammonia to NOx ratio; and
    - Reaction time (1 to 2 seconds required)

26. Operators should provide a cost benefit study using the methodology in H1 (Reference 6), to demonstrate the relative merits of primary measures, SNCR and SCR for the installation. The comparison will show the cost per tonne of NOx abated over the projected life of the plant using the asset lives and typical discount rates given in that document.

Sulphur dioxide

BREF section 4.4.3

The following techniques are recommended to minimise releases of SO_2.

27. *Fuel selection.* Maximum sulphur limit for any fuels should be 1%.

28. Determination of what represents the best protection of the environment as a whole is usually site specific. A process sulphur mass balance should be calculated in order to determine emission levels commensurate with BAT. The calculation should also consider the implications of recycling filter dust into the process.

29. The most important environmental targets related to SOx abatement are:
    - High cullet recycling rates;
    - Minimisation of waste production through internal or external dust recycling;
    - Waste heat recovery;
    - Other atmospheric emission reduction.

    An integrated analysis, prior to the application of desulphurisation, taking into account all effects, side effects, costs, and priorities should be carried out.

Oxides of carbon

BREF section 4.4.5

30. Techniques considered for energy and reduction of other pollutants are sufficient to control emissions of oxides of carbon from melting operations. No additional measures should be necessary – except for Stone Wool cupolas see Section 2.3.2.

Effluent treatment

2.3.7 Abatement of point-source emissions to surface water and sewer

The nature and source of the emissions expected from each activity is given in previous sections and will be confirmed in detail in the Operator's response to Section 3.1. For the Glass Industry in general, emissions to the water environment are relatively low and there are few major issues that are specific to the sector. In general, water is used mainly for cleaning and cooling and can be readily recycled or treated using standard techniques. The main potential sources of water pollution are identified below:

- Spillages or leaks from raw material storage;
- Drainage water from areas contaminated with liquid or solid materials;
- waste water system releases – containing binder residues (from preparation and application/forming areas) and wash down water;
- water used for product cleaning;
- cooling water and cooling water blow down from closed circuit systems;
- scrubbing system purge;
- surface run off and storm water;
- fire fighting.

Excluding domestic wastewater, discharges generally contain only glass solids, some oil contamination, some soluble glass making materials and cooling water system treatment chemicals. Where any potentially harmful materials are used measures can be taken to prevent them entering the water circuit. Wherever practicable closed loop cooling systems can be used and blow down minimised. Standard pollution control techniques can be used to reduce emissions further if necessary. For example: settlement, screening, oil separators, neutralisation, and discharge to municipal wastewater schemes.

In addition to the BREF and the techniques below, guidance on cost-effective effluent treatment techniques can be found in ETBPP Guides (Reference □).

Application form
Question 2.3 (cont.)

Effluent treatment

With the Application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 38 to prevent or reduce point-source emissions to water and land; and in addition
2. Include, where appropriate, off-site treatment in the description of the wastewater treatment system for the activity.
3. Provide, where effluent is discharged, a justification for not cleaning the effluent to a level at which it can be reused (for example by ultrafiltration where appropriate).
4. Describe measures taken to increase the reliability with which the required control and abatement performance is delivered (for instance there may be a biological plant susceptible to bulking or poisoning – what measures ensure reliability? Heavy metals are measured only occasionally – what techniques ensure that they are controlled all the time?).
5. Identify the main chemical constituents of the treated effluent (including the make-up of the Chemical Oxygen Demand (COD)) and assessment of the fate of these chemicals in the environment. These steps will be carried out in response to Sections 3.1 and 4.1 but need to be understood here in order to demonstrate that the controls are adequate. This applies whether treatment is on- or off-site.
6. Identify the toxicity of the treated effluent (see Section 2.10). Until the Regulator's toxicity guidance is available, this should, unless already in hand, normally be carried out as part of an improvement programme.
7. Where there are harmful substances or levels of residual toxicity, identify the causes of the toxicity and the techniques proposed to reduce the potential impacts.
8. Consider whether the effluent flow is sufficient to fall within the requirements of the Urban Waste Water Treatment Directive.

Cont.

Effluent treatment

Indicative BAT requirements

1. The Operator should complete any detailed studies required into abatement or control options (see item 3 in Section 2.3) as an improvement condition to a timescale to be agreed with the Regulator but in any case within the timescale given in Section 1.1;

2. The following general principles should be applied in sequence to control emissions to water:
   - water use should be minimised and wastewater reused or recycled (see Section 0);
   - contamination risk of process or surface water should be minimised (see Section 2.3.9);
   - 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, for example 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. All emissions should be controlled, as a minimum, to avoid a breach of water quality standards (see Sections 3.2 and 4.1), but noting that where BAT can deliver prevention or reduction at reasonable cost it should do so (see Section 1.1). Calculations and/or modelling to demonstrate this will be carried out in response to Section 4.1.

4. With regard to Biological Oxygen Demand (BOD), the nature of the receiving water should be taken into account. However, in IPPC the prevention or reduction of BOD is also subject to BAT and further reductions that can be made at reasonable cost should be carried out. Furthermore, irrespective of the receiving water, the adequacy of the plant to minimise the emission of specific persistent harmful substances must also be considered. Guidance on treatment of persistent substances can be found in Reference 12).

5. Where effluent is treated off-site at a sewage treatment works, the above factors apply in particular demonstrating that:
   - the treatment provided at the sewage treatment works is as good as would be achieved if the emission were treated on-site, based on reduction of load (not concentration) of each substance to the receiving water;
   - the probability of sewer bypass, via storm/emergency overflows or at intermediate sewage pumping stations, is acceptably low;
   - action plans in the event of bypass, such as knowing when bypass is occurring, rescheduling activities such as cleaning, or even shutting down when bypass is occurring;
   - a suitable monitoring programme is in place for emissions to sewer, taking into consideration the potential inhibition of any downstream biological processes and actions planned for any such event.

6. Where any potentially harmful materials are used measures should be taken to prevent them entering the water circuit.

7. Wherever possible, closed loop cooling systems should be used and procedures in place to ensure blow down is minimised.

Continuous filament glass fibre:

BREF section 4.6

8. Releases of organic material from coating preparation and downstream operations should be minimised by the careful handling of materials using defined handling procedures and the effective containment of any spillages (see Section 2.3.9).

9. Flocculation and solids separation techniques should be used where appropriate.

10. If effluent is discharged directly to a watercourse, on site biological treatment should be applied. Careful design and operating procedures are required to ensure the effectiveness of the treatment process is not compromised due to low concentrations and the high proportion of polymeric species.

Cont.

Effluent treatment

Mineral wool:

11. A closed loop process water system should be in place with cooling water blow down, cleaning waters and binder spillages fed into it. A holding tank should be incorporated to accommodate volume overloads, which can then be fed back into the system.

12. Contaminated wastewater may arise from chemical bunds, spillages and oil interceptors. Where such materials are compatible with the process water system they should be added to it; otherwise they should be routed to a holding tank and then disposed of off-site or discharged to sewer.

13. Clean water circuits (for example surface water and cullet quench water) should be designed and operated to minimise the risk of contamination from the process water system. For example, the clean water system should be sealed where it passes through areas where contamination could occur.

Optical fibre:

14. Waste liquor from the wet scrubbers should be neutralised prior to disposal with other site effluent.

2.3.8 Control of fugitive emissions to air

On many installations fugitive, or diffuse, emissions may be more significant than point-source emissions. Common examples of the sources of fugitive emissions are:

- open vessels (for example, the effluent treatment plant);
- storage areas (for example bays, stockpiles, lagoons and the like);
- the loading and unloading of transport containers;
- transferring material from one vessel to another (for example, furnace, ladle, reactors, silos);
- conveyor systems;
- pipework and ductwork systems (for example, pumps, valves, flanges, catchpots, drains, inspection hatches and so on);
- poor building containment and extraction;
- potential for bypass of abatement equipment (to air or water);
- accidental loss of containment from failed plant and equipment.

Application form
Question 2.3 (cont.)

Fugitive emissions to air

With the Application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 38 for control of fugitive emissions to air; and in addition,

2. Identify and, where possible quantify, significant fugitive emissions to air from all relevant sources, estimating the proportion of total emissions that are attributable to fugitive releases for each substance; these steps will be carried out in response to Section 3.1, but need to be understood here in order to demonstrate that the controls are adequate.

3. The Operator should demonstrate how dust emissions in the furnace feed area are controlled. Techniques should include:
   - Batch moisture;
   - Slight reduced pressure within the furnace;
   - Provision of extraction which vents to a filter system;
   - Enclosed screw feeders;
   - Enclosure of feed pockets;

   The use of other techniques should be justified.

4. The Operator should demonstrate what procedures are used to control dust emissions when dry batch materials are used (see BAT requirement 3 below).

Indicative BAT requirements

1. The Operator should complete any detailed studies required into abatement or control options (see item 3 in Section 2.3) as an improvement condition to a timescale to be agreed with the Regulator, but in any case within the timescale given in Section 1.1.

2. Where there are opportunities for reductions, the Permit may require the updated inventory of fugitive emissions to be submitted on a regular basis.

3. *Dust* - The following general techniques should be employed where appropriate:
   - covering of skips and vessels;
   - avoidance of outdoor or uncovered stockpiles (where possible);
   - where unavoidable, use of sprays, binders, stockpile management techniques, windbreaks and so on;
   - regular wheel and road cleaning (avoiding transfer of pollution to water and wind blow);
   - closed conveyors, pneumatic conveying (noting the higher energy needs), minimising drops. Filters on the conveyors to clean the transport air prior to release;
   - regular housekeeping;
   - enclosed silos (for storage of bulk powder materials) vented to fabric filters with the collected material returned to the silo or recycled to the furnace;

Cont

Fugitives

- enclosed containers or sealed bags used for smaller quantities of fine materials;

4. 0.4% of water should be maintained in the batch to reduce duct during conveying and to prevent carry over of fine particulate out of the furnace.

5. Areas of the process where dust is likely to be generated (for example, bag opening, frit batch mixing, fabric filter dust disposal and the like) should be provided with extraction which vents to suitable abatement.

6. *Batch plants* – building design should minimise the movement of accumulated dust (for example minimum number of openings, use of dust curtains and seals). All measures should be fully functional and be properly maintained as part of a regular maintenance schedule.

7. ***VOCs***

   When transferring volatile liquids, the following techniques should be employed – subsurface filling via filling pipes extended to the bottom of the container, the use of vapour balance lines that transfer the vapour from the container being filled to the one being emptied, or an enclosed system with extraction to suitable abatement plant.

   Vent systems should be chosen to minimise breathing emissions (for example pressure/ vacuum valves) and, where relevant, should be fitted with knock-out pots and appropriate abatement equipment.

   Maintenance of bulk storage temperatures as low as practicable, taking into account changes due to solar heating etc.

8. The following techniques should be used (together or in any combination) to reduce losses from storage tanks at atmospheric pressure:
   - Tank paint with low solar absorbency;
   - Temperature control;
   - Tank insulation;
   - Inventory management;
   - Floating roof tanks;
   - Bladder roof tanks;
   - Pressure/vacuum valves, where tanks are designed to withstand pressure fluctuations;
   - Specific release treatment (such as adsorption, adsorption, condensation);

9. For Information on *Odour,* see Section 2.3.10.

2.3.9 Control of fugitive emissions to surface water, sewer and groundwater

Application form
Question 2.3 (cont.)

Fugitive emissions to water

With the Application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 38 for control of fugitive emissions to air; and in addition,
2. Identify and ,where possible quantify, significant fugitive emissions to water from all relevant sources, estimating the proportion of total emissions that is attributable to fugitive releases for each substance; these steps will be carried out in response to Section 3.1, but need to be understood here in order to demonstrate that the controls are adequate.

Indicative BAT requirements

1. Where there are opportunities for reductions, the Permit may require the updated inventory of fugitive emissions to be submitted on a regular basis.
2. With regard to subsurface structures, 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 ensure leakages from pipes and the like are minimised and are easily detected if they do occur, particularly where hazardous (that is, 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, for example pressure tests, leak tests, material thickness checks or CCTV.
3. As for surfacing, the Operator should:
   - describe the design[(#)] and condition of the surfacing of all operational areas;
   - 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.

   (# Relevant information may include as appropriate: capacities; thicknesses; falls; material; permeability; strength/reinforcement; resistance to chemical attack; inspection and maintenance procedures; and quality assurance procedures.)
4. All tanks containing liquids whose spillage could be harmful to the environment should be bunded. For further information on bund sizing and design, see Reference 12. Bunds should:
   - be 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;
   - be designed to catch leaks from tanks or fittings;
   - have a capacity greater than 110 percent of the largest tank or 25 percent of the total tankage;
   - be subject to regular visual inspection and any contents pumped out or otherwise removed under manual control after checking for contamination;
   - where not frequently inspected, be fitted with a high-level probe and an alarm as appropriate;
   - have fill points within the bund where possible or otherwise provide adequate containment;
   - have a routine programmed inspection of bunds (normally visual, but extending to water testing where structural integrity is in doubt).

Odour

2.3.10 Odour

Application form
Question 2.3 (cont.)

Odour control

With the Application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 38 for odour control; and in addition,

2. Where odour could be a problem, the Operator should categorise the emissions as follows:

   a. *a high-level release that is expected to be acknowledged in the Permit* – that is, there will be an allowed release from the process (such as an odorous release from a stack or high-level scrubber) and an element of BAT is adequate dispersion between source and receptor to prevent odour nuisance. The release will be allowed under the Permit but it is acknowledged that, under certain conditions, the plume may ground causing odour problems. Conditions in Permits are likely to be based on the actions to take when such events occur.

   b. *release should be preventable* – that is, releases can normally be contained within the site boundary by using BAT such as containment, good practice or odour abatement.

   c. *release is not preventable under all circumstances,* for example, from a landfill or uncovered effluent treatment plant, but potential problems are controlled by a programme of good practice measures.

3. For each relevant category, demonstrate that there will not be an odour problem from the emissions under normal conditions (see odour guidance).

4. For each relevant category, identify the actions to be taken in the event of abnormal events or conditions that might lead to odour, or potential odour problems (see odour guidance).

5. Describe the current or proposed position with regard to any techniques given below or in Reference 23.

Indicative BAT requirements

1. Where appropriate, an **Odour Management Plan** should be maintained. Guidance on the need for and the preparation of an odour plan is given in the separate guidance *Odour Assessment and Control – Guidance for Regulators and Industry,* (see Reference 23).

Mineral wool processes:

BREF section 4.5.6.5

2. Releases of odour from melting operations (release of binder breakdown products from recycled material) should be minimised by pre-treating the fibre or adding oxidising agents.

3. Significant emissions of hydrogen sulphide can arise from **stone wool cupola** melting operations. These should be minimised by combustion in an afterburner system (see Section 2.3.2).

4. Odours from forming area emissions should be minimised by wet scrubbing (see Section 2.3.2) and adequate dispersion. If the odour problem persists, it should be addressed by wet scrubbing using an oxidising agent, ensuring this is kept separate from the process water system.

5. Odour releases from curing ovens should be minimised by:
   - Good oven maintenance and cleaning
   - Wet scrubbing
   - Adequate dispersion
   - Provision for the rapid extinguishing of any fires
   - Incineration of curing oven waste gases.

6. Odour releases from product cooling should be minimised by ensuring procedures are in place to prevent over-curing of the product.

Cont.

Odour

7. Further guidance on control techniques is given in Reference 23, which also gives information on assessment and on dispersion design criteria.

8. Odour plans, where needed, should be operating within the timescale given in Section 1.1. However, it should be noted that, if there are local problems, the Regulator is likely to require it to be programmed early within the list of work to be carried out by that date.

2.4 Emissions to groundwater

Groundwater protection legislation

The Groundwater Regulations for the UK came into force on 1 April 1999. An IPPC Permit will be subject to the following requirements under these Regulations.

i. It shall not be granted at all if it would permit the direct discharge of a List I substance (Regulation 4(1)) except in limited circumstances – see note 1, below.

ii. If the Permit allows the disposal of a List I substance or any other activity that might lead to an *indirect discharge* (see note 2, below) of a List I substance then *prior investigation* (as defined in Regulation 7) is required and the Permit shall not be granted if this reveals that indirect discharges of List I substances would occur and in any event conditions to secure prevention of such discharges must be imposed (Regulation 4(2) and (3)).

iii. In the case of List II substances, Permits allowing direct discharges or possible indirect discharges cannot be granted unless there has been a prior investigation and conditions must be imposed to prevent groundwater pollution (Regulation 5).

iv. The Regulations contain further detailed provisions covering *surveillance* of groundwater (Regulation 8); conditions required when direct discharges are permitted (Regulation 9); when indirect discharges are permitted (Regulation 10); and review periods and compliance (Regulation 11).

The principles, powers and responsibilities for groundwater protection in England and Wales, together with the Agency's policies in this regard, are outlined in the Environment Agency's document *Policy and Practice for the Protection of Groundwater* (PPPG) (see Reference 24). This outlines the concepts of vulnerability and risk and the likely acceptability from the Agency's viewpoint of certain activities within groundwater protection zones.

A **Prior investigation** of the potential effect on groundwater of on-site disposal activities or discharges to groundwater. Such investigations will vary from case to case, but the Regulator is likely to require a map of the proposed disposal area; a description of the underlying geology, hydrogeology and soil type, including the depth of saturated zone and quality of groundwater; the proximity of the site to any surface waters and abstraction points, and the relationship between ground and surface waters; the composition and volume of waste to be disposed of; and the rate of planned disposal.

B **Surveillance** - this will also vary from case to case, but will include monitoring of groundwater quality and ensuring the necessary precautions to prevent groundwater pollution are being undertaken.

Note 1 The Regulations state that, subject to certain conditions, the discharges of List I substances to groundwater may be authorised if the groundwater is "permanently unsuitable for other uses". Advice must be sought from the Regulator where this is being considered as a justification for such discharges.

Note 2 List I and List II refer to the list in the Groundwater Regulations and should not be confused with the similar lists in the Dangerous Substances Directive.

Application form Question 2.4

Identify if there may be a discharge of any List I or List II substances and, if any are identified, explain how the requirements of the Groundwater Regulations 1998 have been addressed.

With the Application the Operator should:

Meeting the requirements of the Groundwater Regulations

1. Confirm that there are no direct or indirect emissions to groundwater of List I or List II substances from the installation, or

2. Where there are such releases, provide the information and surveillance arrangements described in A and B above.

Under these Regulations the Permit may not be granted if the situation is not satisfactory. Therefore, with the application, the Operator should supply information on List I and List II substances and, if necessary, prior investigation and surveillance information:

Groundwater

List I and List II substances (as in Groundwater Regulations)

List I

1.-(1) Subject to sub-paragraph (2) below, a substance is in List I if it belongs to one of the following families or groups of substances-

(a) organohalogen compounds and substances that may form such compounds in the aquatic environment;

(b) organophosphorus compounds;

(c) organotin compounds;

(d) substances that possess carcinogenic, mutagenic or teratogenic properties in or via the aquatic environment (including substances that have those properties that would otherwise be in List II);

(e) mercury and its compounds;

(f) cadmium and its compounds;

(g) mineral oils and hydrocarbons;

(h) cyanides.

1.-(2) A substance is not in List I if it has been determined by the Regulator to be inappropriate to List I on the basis of a low risk of toxicity, persistence and bioaccumulation.

List II

2.-(1) A substance is in List II if it could have a harmful effect on groundwater and it belongs to one of these families or groups of substances:

(a) the following metalloids and metals and their compounds:

zinc	tin	copper
barium	nickel	beryllium
chromium	boron	lead
uranium	selenium	vanadium
arsenic	cobalt	antimony
thallium	molybdenum	tellurium
titanium	silver	

(b) biocides and their derivatives not appearing in List I;

(c) substances that have a harmful effect on the taste or odour of groundwater, and compounds liable to cause the formation of such substances in such water and to render it unfit for human consumption;

(d) toxic or persistent organic compounds of silicon, and substances that may cause the formation of such compounds in water, excluding those which are biologically harmless or are rapidly converted in water into harmless substances;

(e) inorganic compounds of phosphorus and elemental phosphorus;

(f) fluorides;

(g) ammonia and nitrites

2.-(2) A substance is also in List II if:

(a) it belongs to one of the families or groups of substances set out in paragraph 1(1) above;

(b) it has been determined by the Regulator to be inappropriate to List I under paragraph 1(2); and

(c) it has been determined by the Regulator to be appropriate to List II having regard to toxicity, persistence and bioaccumulation.

3.-(1) The Secretary of State or Scottish Ministers may review any decision of the Regulator in relation to the exercise of its powers under paragraph 1(2) or 2 (2).

3.-(2) The Secretary of State or Scottish Ministers shall notify the Regulator of his decision following a review under sub-paragraph (1) above and it shall be the duty of the Regulator to give effect to that decision.

4.- The Regulator shall from time to time publish a summary of the effect of its determinations under this Schedule in such manner as it considers appropriate and shall make copies of any such summary available to the public free of charge.

2.5 Waste handling

The normal nature and source of the waste from each activity is given in Section 2.3 and will be confirmed in detail in the Operator's response to Section 3.1. In general, a characteristic of the Glass Industry is that most of the activities produce relatively low levels of solid waste. Most of the processes do not have significant inherent by-product streams. The process residues consist of unused raw materials and waste glass that has not been converted into the product. The main process residues encountered are:

- waste batch materials;
- dust collected from waste gas streams;
- melt not converted into product;
- waste product;
- solid waste from wastewater system.

Application form Question 2.5

Characterise and quantify each waste stream and describe the proposed measures for waste management storage and handling.

With the Application the Operator should:

1. Identify and quantify the waste streams.
2. Identify the current or proposed handling arrangements.
3. Describe the current or proposed position with regard to the techniques below or any others which are pertinent to the installation.
4. Demonstrate that the proposals are BAT by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the *A1 Guide for Applicants*) or alternative measures.

Indicative BAT requirements

1. A system should be maintained to record the quantity, nature, origin and, where relevant, the destination, frequency of collection, mode of transport and treatment method of any waste that is disposed of or recovered.
2. Wherever practicable, waste should be segregated and the disposal route identified. This should be as close to the point of production as possible.
3. Records should be maintained of any waste sent off-site (Duty of Care).
4. Storage areas should be located away from watercourses and sensitive boundaries, for example, adjacent to areas of public use, and should be protected against vandalism.
5. Storage areas should be clearly marked and signed plus containers should be clearly labelled.
6. The maximum storage capacity of storage areas should be stated and not exceeded. The maximum storage period for containers should be specified.
7. Appropriate storage facilities should be provided for special requirements such as for substances that are flammable, sensitive to heat or light and the like; also incompatible waste types should be kept separate.
8. Containers should be stored with lids, caps and valves secured and in place. This also applies to emptied containers.
9. Storage containers, drums and the like should be regularly inspected.
10. Procedures should be in place to deal with damaged or leaking containers.
11. All appropriate steps to prevent emissions (for example, liquids, dust, VOCs and odour) from storage or handling should be taken (see Sections 2.3.8, 2.3.9 and 2.3.10).

2.6 Waste recycling, recovery or disposal

The Regulations require the Regulator, in setting Permit conditions, to take account of certain general principles, including that the installation in question should be operated in such a way that "waste production is avoided in accordance with Council Directive 75/442/EEC on waste; and where waste is produced it is recovered, or where this is technically or economically impossible it is disposed of, while avoiding or reducing the impact on the environment". The objectives of the National Waste Strategies should also be considered. Waste avoidance (minimisation) is covered throughout Section 2.3 and by the specific requirement for a waste minimisation audit in Section 2.2.2.

In order to meet this requirement, the Regulator needs Operators to provide the information below.

Application form Question 2.6

Describe how you propose to recover or dispose of each waste stream. If you propose any disposal, explain why recovery is technically and economically impossible and describe the measures planned to avoid or reduce any impact on the environment.

With the Application the Operator should:

1. Describe, in respect of each waste stream produced by the installation, whether the waste in question is to be recovered or disposed of, and if a disposal option is planned, to justify why recovery is "technically and economically impossible" together with "the measures planned to avoid or reduce any impact on the environment".
2. Include in the description whether, in the Operator's view, waste disposal is likely to be restricted by implementing the Landfill Directive.
3. Describe the current or proposed position with regard to the techniques below or any others which are pertinent to the installation.
4. Demonstrate that the proposals are BAT by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the *A1Guide for Applicants*) or alternative measures.

Indicative BAT requirements

BREF section 4.7

1. Unless agreed with the Regulator to be inappropriate, the Operator should provide a detailed assessment identifying the best environmental options for waste disposal. For existing activities, this may be carried out as an improvement condition to a timescale to be approved by the Regulator.
2. *Waste batch materials* arising from materials handling and storage should be recycled to the process whenever possible. Waste from this source should be minimised using the techniques laid down in Section 2.3.8.
3. *Dust collected from waste gas streams* should be recycled to the process whenever practicable.
4. Dust deposited in the regenerators during a furnace campaign should be disposed of to an appropriately licenced site at the end of the campaign.
5. *Melt not converted to product - w*henever possible should be cooled and shattered in water and the resulting cullet used as raw material (exceptions: continuous filament glass fibre production where waste material (from process interruption) is fibrous; and drain glass).
6. Waste material from stone wool processes should be briquetted and recycled.
7. *Waste product* – procedures to minimise waste generated from out of specification material, edge trims and so on should be implemented.
8. In the Mineral Wool sector, fibrous product waste should, wherever practicable, be processed and sold as blowing wool; or recycled to the furnace after briquetting.

2.7 Energy

Glass making is energy intensive and the choices of energy source, heating technique and heat recovery method are central to the design of the furnace. The three main energy sources are fuel oil, natural gas and electricity, except for the manufacture of stone wool where the predominant melting technique is the hot blast cupola, which is fuelled by coke.

In general, the energy necessary for melting glass accounts for over 75% of the total energy requirements of glass manufacture. Other significant areas of energy use are forehearths, the forming process, annealing, factory heating and general services. In the Mineral Wool Sector the fiberising operation and the curing oven are also major energy consumers

Fuel oil and natural gas are the predominant energy sources for melting, with a small percentage of electricity. Forehearths and annealing lehrs are heated by gas or electricity, and electrical energy is used to drive air compressors and fans needed for the process. General services include water pumping, steam generation for fuel storage and trace heating, humidification/heating of batch, and heating buildings. Some furnaces have been equipped with waste heat boilers to produce part or all of the steam required

The actual energy requirements experienced in the various sectors vary widely from about 3.5 to over 40 GJ/tonne. This figure depends very heavily on the furnace design, scale and method of operation. The Table below provides a summary of energy requirements.

BREF sections 4.2.1, 4.4.2.5, 4.8

Because glass making is such an energy intensive, high temperature process there is clearly a high potential for heat loss. Electrically heated and oxy-fuel fired furnaces generally have better specific energy efficiencies than fossil fuel furnaces, but have associated drawbacks which are discussed in more detail in the BREF (see Sections 4.2.1 and 4.4.2.5 of the BREF)

Some of the more general factors affecting the energy consumption of fossil fuel fired furnaces are:

- The capacity of the furnace;
- Furnace throughput;
- Age of a furnace;
- The use of electric boost;
- The use of cullet;
- Oxy-fuel firing.

For any particular installation, site specific issues affecting the above factors will need to be taken into account.

The cost of energy for melting is one of the largest factors in operational costs for glass installations and there is a significant incentive for Operators to reduce energy use. Economic savings have traditionally been the motivation for implementing energy saving techniques, but recently the environmental aspects of energy use have increased in importance. In fossil fuel fired furnaces the energy use also affects the emissions per tonne of glass of those substances which relate directly to the amount of fossil fuel burned, particularly CO_2, SO_2 and NOx, but also particulate matter.

Table 2.2: Energy consumption for processes

Process	Energy Consumption		Comments
	Melting (GJ/tonne of melt)	Overall (GJ/tonne of product	
Continuous filament glass fibre	11 – 23. Can be up to 30 for small furnaces with specialised compositions	18 - 33	Source: BREF
Glass wool	2.2 - 10	11 – 22	Source: BREF
Stone and slag wool	2.1 – 12.6	7 – 18	Source: BREF
Ceramic fibre	6.5 – 16.5	3.5 – 9.5 (figures based on 75% conversion of raw materials to finished product)	Source: BREF Little information available.
Frits	13	Low	Source: BREF Little information available.
Optical fibre	-	-	No data available

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 requirements in Sections 2.7.1 and 2.7.2 below and is a participant to a Climate Change Agreement (CCA) or Trading Agreement with the government.

or

- the Operator meets the basic energy requirements in Sections 2.7.1 and 2.7.2 below and the further sector-specific energy requirements in Section 2.7.3 below.

Note that even where a CCA or Trading Agreement is in place, this does not preclude the consideration of energy efficiency as part of an integrated assessment of BAT in which it may be balanced against other emissions.

Further guidance is given in the Energy Efficiency Guidance Note (Reference 14).

2.7.1 Basic energy requirements (1)

Application form Question 2.7 (part 1)

Provide a breakdown of the energy consumption and generation by source and the associated environmental emissions.

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

With the Application the Operator should:

1. Provide the following energy consumption information in terms of delivered energy and also, in the case of electricity, converted to primary energy consumption. For the public electricity supply, a conversion factor of 2.6 should be used. Where applicable, the use of factors derived from on-site heat and/or power generation, or from direct (non-grid) suppliers should be used. In the latter cases, the Applicant should provide details of such factors. Where energy is exported from the installation, the Applicant should also provide this information. An example of the format in which this information should be presented is given in Table 2.3 below. The Operator should also supplement this with energy flow information (such as “Sankey” diagrams or energy balances) showing how the energy is used throughout the process.

   (Note that the Permit will require this information to be submitted annually.)

   Table 2.3: Example breakdown of delivered and primary energy consumption

Energy source	Energy consumption		
	Delivered, MWh	Primary, MWh	% of total
Electricity*			
Gas			
Oil			
Other (Operator to specify)			

   * specify source.

2. Provide the following Specific Energy Consumption information. The Operator should define and calculate the specific energy consumption of the activity (or activities) based on primary energy consumption for the products or raw material inputs that most closely match the main purpose or production capacity of the installation. The Operator should provide a comparison of specific energy consumption against any relevant benchmarks available for the sector.

3. Provide associated environmental emissions. This is dealt with in the Operator’s response to Section 3.1.

2.7.2 Basic energy requirements (2)

Application form
Question 2.7 (part 2)

Describe the proposed measures for improving energy efficiency.

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

With the Application the Operator should:

1. Describe the current or proposed position with regard to the basic, low-cost energy requirements below, and provide justifications for not using any of the techniques described.

2. Provide an energy efficiency plan that appraises the costs and benefits of different energy options as described below.

Basic energy requirements

1. *Operating, maintenance and housekeeping measures* should be in place in the following areas, according to the checklists provided in Appendix 2 of the *IPPC Energy Efficiency Guidance Note*, where relevant:
   - air conditioning, process refrigeration and cooling systems (leaks, seals, temperature control, evaporator/condenser maintenance);
   - operation of motors and drives;
   - compressed gas systems (leaks, procedures for use);
   - steam distribution systems (leaks, traps, insulation);
   - space heating and hot-water systems;
   - lubrication to avoid high-friction losses;
   - boiler maintenance, for example, optimising excess air;
   - other maintenance relevant to the activities within the installation.

2. *Basic, low cost, physical techniques* should be in place to avoid gross inefficiencies. These should include insulation, containment methods, (such as seals and self-closing doors), and avoidance of unnecessary discharge of heated water or air (for example, by fitting simple control systems).

3. *Building services energy-efficiency techniques* should be in place to deliver the requirements of the Building Services section of the *Energy Efficiency Guidance Note*. For energy-intensive industries these issues may be of minor impact and should not distract effort *from* the major energy issues. They should nonetheless find a place in the programme, particularly where they constitute more than 5 percent of the total energy consumption.

4. *An energy efficiency plan* should be provided that:
   - identifies all techniques relevant to the installation, including those listed below and in Section 2.7.3;
   - identifies the extent to which these have been employed;
   - prioritises the applicable techniques according to the appraisal method provided in the *Energy Efficiency Guidance Note* which includes advice on appropriate discount rates, plant life and the like;
   - identifies any techniques that could lead to other adverse environmental impacts, thereby requiring further assessment (for example, according to methodology, see Reference 6).

   Where other appraisal methodologies have been used, state the method, and provide evidence that appropriate discount rates, asset life and expenditure (£/t) criteria have been employed.

   This should be submitted in a summary format similar to the example in Table 2.4, together with supporting information from any appraisal procedure carried out. The plan is required to ensure that the Operator has considered all relevant techniques. **NB**: However, where a CCA or Trading Agreement is in place the Regulator will only enforce implementation of those measures in categories 1-3 above.

Cont.

Table 2.4: Example format for energy-efficiency measures

Energy-efficiency option	NPV £k	CO_2 savings (tonnes)		NPV/CO_2 saved £/tonne	Priority* for implementation
		annual	lifetime		
7MW CHP plant	1,372	13,500	135,000	10	high
High-efficiency motor	0.5	2	14	35	medium
Compressed air	n/a	5	n/a	n/a	immediate

* Indicative only, based on cost/benefit appraisal:

Where a CCA or Trading Agreement is in place, the energy efficiency plan should be submitted as an improvement condition to a timescale to be agreed with the Regulator, but in any case within the timescale given in Section 1.1.

5. *Energy management techniques* should be in place, according to the requirements of Section 2.1 noting, in particular, the need for monitoring of energy flows and targeting of areas for reductions.

2.7.3 Further energy-efficiency requirements

Application form
Question 2.7 (part 3)

Describe the proposed measures for improvement of energy efficiency.(only where the installation is not the subject of a CCA or Trading Agreement).

Where there is no CCA or Trading Agreement in place, the Operator should demonstrate the degree to which the further energy-efficiency measures identified in the implementation plan, including those below, have been taken into consideration for this sector and justify where they have not.

With the Application the Operator should:

1. Identify which of the measures below are applicable to the activities, and include them in the appraisal for the energy-efficiency plan in Section 2.7.2.
2. Describe the current or proposed position with regard to the techniques below, or any others that are pertinent to the installation.
3. Demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the *A1 Guide for Applicants*) or alternative measures.

Indicative BAT requirements

BAT for energy

The following techniques should be implemented where they are judged to be BAT based on a cost/benefit appraisal according to the methodology provided in Appendix 4 of the *Energy Efficiency Guidance Note* (Reference 14).

BREF sections 4.8.1 to 4.8.5

1. **Energy-efficiency techniques**
   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.
   - Choice of melting technique and furnace design:
     - Increase the quantity of refractory bricks employed in regenerator furnaces;
     - Improve heat transfer by using specially shaped packing and fusion cast materials, for example, fusion cast corrugated cruciforms;
     - Furnace geometry changes;
     - Use of electrical melting or oxy-fuel melting, where feasible.

Cont.

BAT for energy (cont,)

- Increased level of furnace insulation, for example sprayed fibre insulation when applied to the regenerator structure.

- Combustion control and fuel choice:
  - Natural gas firing;
  - Use of low NOx burners.
- Cullet usage:
  - Recycling of all internal cullet (exceptions: continuous filament glass fibre, stone wool, frit).
- Use of waste heat boiler where applicable and economically feasible.
- Batch and cullet preheating by direct or indirect means (exception: stone wool cupola). Preheating of only batch has been problematic and is not considered a proven technology. The use of a direct preheater causes increased emissions of particulate matter and secondary particulate abatement is necessary. The collected dusts can normally be recycled into the furnace. Issues of potential odour generation and dioxin emissions must also be taken into account. The Operator should demonstrate how these are controlled and minimised.

2. **Energy supply techniques**

The following techniques should be considered:

- use of Combined Heat and Power (CHP);
- recovery of energy from waste;
- use of less polluting fuels.

The Operator should provide justification that the proposed or current situation represents BAT, irrespective of whether a CCA or Trading Agreement is in place, where there are other BAT considerations involved, such as:

- the choice of fuel impacts upon emissions other than carbon, for example, sulphur in fuel;
- where the potential minimisation of waste emissions by recovery of energy from waste conflicts with energy efficiency requirements.

Where there is an on-site combustion plant other guidance is also relevant. For plants greater than 50MW, Operators should consult the IPC guidance on power generation (reference IPC S2 1.01 *Combustion Processes: Large boilers and furnaces 50MW(th) and over* and supplement IPC S3 1.01 *Combustion Processes*). Operators of plant of 20-50MW should consult the Local Authority Air Pollution Control guidance. On IPPC installations this guidance will be generally applicable to plant under 20MW also. For incineration plant S2.501 *Waste Incineration* should be consulted.

2.8 Accidents and their consequences

Guidance

IPPC requires as a general principle that necessary measures should be taken to prevent accidents that may have environmental consequences, and to limit those consequences. This section covers general areas of any installation operations that have the potential for accidental emission. Accidents in this context include any abnormal operation which may increase emissions.

Some installations will also be subject to the Control of Major Accident Hazards Regulations 1999 (COMAH) (see Appendix 2 for equivalent legislation in Scotland and Northern Ireland). There is an element of overlap between IPPC and COMAH and some systems and information for both regimes may be interchangeable.

The COMAH regime applies to major hazards. For accident aspects covered by COMAH, refer to any reports already held by the Regulator. However, the accident provisions under IPPC may fall beneath the threshold for major accident classification under COMAH and therefore consideration should be given to smaller accidents and incidents as well. Guidance (see Reference 19), prepared in support of the COMAH Regulations may also help IPPC Operators (whether or not they are covered by the COMAH regime), in considering ways to reduce the risks and consequences of accidents.

General management requirements are covered in Section 2.1. For accident management, there are three particular components:

- identification of the hazards 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 do occur.

Application form
Question 2.8

Describe the documented system that you proposed to be used to identify, assess and minimise the environmental risks and hazards of accidents and their consequences.

With the Application the Operator should:

1. Provide the accident-management plan described in the indicative BAT requirements below describing the current or proposed position with regard to the techniques listed below or any others that are pertinent to the installation.

2. Demonstrate that the proposals are BAT by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the *Guide for Applicants*) or alternative measures.

3. Identify any issues that may be critical.

Indicative BAT requirements

BAT for control of accidents

1. A structured accident management plan should be submitted to the Regulator that should:

   a. ***identify the hazards*** to the environment posed by the installation. Particular areas to consider may include, but should not be limited to, the following:
   - transfer of substances (for example, loading or unloading from or to vessels);
   - overfilling of vessels;
   - failure of plant and/or equipment (for example, over-pressure of vessels and pipework, blocked drains);
   - failure of containment (such as bund and/or overfilling of drainage sumps);
   - 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.

Cont.

BAT for control of accidents (cont.)

b. ***assess the risks.*** Having identified the hazards, the process of assessing the risks can be viewed as addressing six basic questions:

1. what is the estimated probability of their occurrence? (source frequency);
2. what gets out and how much? (risk evaluation of the event);
3. where does it get to? (predictions for the emission – what are the pathways and receptors?);
4. what are the consequences? (consequence assessment – the effects on the receptors);
5. what are the overall risks? (determination of the overall risk and its significance to the environment);
6. what can prevent or reduce the risk? (risk management – measures to prevent accidents and/or reduce their environmental consequences).

The depth and type of assessment will depend on the characteristics of the installation and its location. The main factors that should be taken into account are:

- the scale and nature of the accident hazard presented by the installation and the activities;
- the risks to areas of population and the environment (receptors);
- the nature of the installation and complexity or otherwise of the activities and the relative difficulty in deciding and justifying the adequacy of the risk-control techniques.

c. ***identify the techniques necessary to reduce the risks.*** *These techniques will include*

c1. the following techniques, which are relevant to most installations:

- an inventory should be maintained of substances, present or likely to be present, which could have environmental consequences if they escape. Do not forget that many apparently innocuous substances can be environmentally damaging if they escape (for example, a tanker of milk spilled into a watercourse could destroy its ecosystem). The Permit will require the Regulator to be notified of any changes to the inventory;
- procedures should be in place for checking raw materials and wastes to ensure compatibility with other substances with which they may accidentally come into contact;
- adequate storage arrangements for raw materials, products and wastes should be provided;
- to ensure that control is maintained in emergency situations, consideration should be given to process design alarms, trips and other control aspects, for example, automatic systems based on microprocessor control and passing valve control, tank level readings such as ultrasonic gauges, high-level warnings and process interlocks and process parameters;
- preventative techniques, such as suitable barriers to prevent damage to equipment from the movement of vehicles, should be included as appropriate;
- appropriate containment should be provided, for example, bunds and catchpots, building containment;
- techniques and procedures should be implemented to prevent overfilling of storage tanks (liquid or powder), for example, level measurement, independent high-level alarms, high-level cut-off, and batch metering;
- installation security systems to prevent unauthorised access should be provided as appropriate and should include maintenance arrangements where necessary;
- there should be an installation log/diary to record all incidents, near-misses, changes to procedures, abnormal events and findings of maintenance inspections;
- procedures should be established to identify, respond to and learn from such incidents;
- the roles and responsibilities of personnel involved in accident management should be identified;

Cont.

BAT for control of accidents (cont.)

- clear guidance should be available on how each accident scenario should be managed, for example, containment or dispersion, to extinguish fires or let them burn;
- procedures should be in place to avoid incidents occurring as a result of poor communication among operations staff during shift changes and maintenance or other engineering work;
- safe shutdown procedures should be in place;
- communication routes should be established with relevant authorities and emergency services both before and in the event of an accident. Post-accident procedures should include the assessment of harm caused and steps needed to redress this;
- appropriate control techniques should be in place to limit the consequences of an accident, such as oil spillage equipment, isolation of drains, alerting of relevant authorities and evacuation procedures;
- personnel training requirements should be identified and provided;
- the systems for the prevention of fugitive emissions are generally relevant (Sections 2.3.8 and 2.3.9) and in addition, for drainage systems:
  - procedures should be in place to ensure that the composition of the contents of a bund sump, or sump connected to a drainage system, are checked before treatment or disposal;
  - drainage sumps should be equipped with a high-level alarm or sensor with automatic pump to storage (not to discharge);
  - there should be a system in place to ensure that sump levels are kept to a minimum at all times;
  - high-level alarms and the like should not be routinely used as the primary method of level control;
  -

c2. the following, plus any other specific techniques identified as necessary to minimise the risks as identified in 1a and 1b above:

- adequate redundancy or standby plant should be provided with maintenance and testing to the same standards as the main plant;
- process waters, site drainage waters, emergency firewater, chemically contaminated waters and spillages of chemicals should, where appropriate, be contained and, where necessary, routed to the effluent system, with provision to contain surges and storm-water flows, and treated before emission to controlled waters or sewer. Sufficient storage should be provided to ensure that this could be achieved. There should also be spill contingency procedures to minimise the risk of accidental emission of raw materials, products and waste materials and to prevent their entry into water. Any emergency firewater collection system should also take account of the additional firewater flows or fire-fighting foams. Emergency storage lagoons may be needed to prevent contaminated firewater reaching controlled waters (see References 15 and 16);
- consideration should be given to the possibility of containment or abatement for accidental emissions from vents and safety relief valves/bursting discs. Where this may be inadvisable on safety grounds, attention should be focused on reducing the probability of the emission;

2.9 Noise and vibration

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

The PPC Regulations require installations to be operated in such a way that *"all the appropriate preventative measures are taken against pollution, in particular through the application of BAT*". The definition of pollution includes *"emissions that may be harmful to human health or the quality of the environment, cause offence to human senses or impair or interfere with amenities and other legitimate uses of the environment".* BAT is therefore likely to be similar, in practice, to the requirements of the statutory nuisance legislation, which requires the use of "best practicable means" to prevent or minimise noise nuisance. It is understood that raw material handling can generate noise where glass is being recycled or broken up. It is suggested that consideration be given to the use of sonic booths or sound proofing to control the generation of noise where such activities are being carried out.

In the case of noise, "offence to any human senses" can normally be judged by the likelihood of complaints, but in some cases it may be possible to reduce noise emissions still further at reasonable costs, and this may exceptionally therefore be BAT for noise emissions.

For advice on how noise and/or vibration related limits and conditions will be determined see *"IPPC Noise – Part 1 Regulation and Permitting",* (see Reference 20).

Application form
Question 2.9

Describe the main sources of noise and vibration (including infrequent sources); the nearest noise-sensitive locations and relevant environmental surveys which have been undertaken; and the proposed techniques and measures for the control of noise.

Information needed to determine BAT for noise and vibration

With the Application the Operator should:

1. Provide the following information for *each main source of noise and vibration* that falls within the IPPC installation:
   - the source and its location on a scaled plan of the site;
   - whether continuous/intermittent, fixed or mobile;
   - the hours of operation;
   - its description (for example clatter, whine, hiss, screech, hum, bangs, clicks, thumps or tonal elements);
   - its contribution to overall site noise emission (categorise each as high, medium or low unless supporting data is available).

   A common-sense approach needs to be adopted in determining which sources to include. The ones that need to be considered are those that may have environmental nuisance impact; for example, a small unit could cause an occupational noise issue in an enclosed space but would be unlikely to cause an environmental issue. Conversely a large unit or a number of smaller units enclosed within a building could, for example, cause a nuisance if doors are left open. Remember that noise, which is not particularly noticeable during the day, may become more noticeable at night.
2. Provide the information required in 1, for each source plus its times of operation. For *Infrequent sources of noise and vibration,* not listed above that fall within the IPPC installation: (such as infrequently operated/ seasonal operations, cleaning/maintenance activities, on-site deliveries/collections/transport or out-of-hours activities, emergency generators or pumps and alarm testing),
3. Identify *the nearest noise-sensitive sites* (typically dwellings, parkland and open spaces – schools, hospitals and commercial premises *may* be considered noise-sensitive, depending upon the activities undertaken there) and any other points/boundary where conditions have been applied by local authority officers or as part of a planning consent, relating to:

   (a) the local environment:
   - provide an accurate map or scaled plan showing grid reference, nature of the receiving site, distance and direction from site boundary;

Cont.

Information needed to determine BAT for noise and vibration (cont.)

(b) conditions/limits imposed that relate to other locations (that is, boundary fence or surrogate for nearest sensitive receptor):

- any planning conditions imposed by the local authority (day/evening/night*);
- other conditions imposed by agreements, for example, limits on operating times, technologies and the like;
- any requirements of legal notices and the like.

(c) the noise environment:

- background noise level, if known (day/evening/night) $L_{A,90,T}$;
- specific noise level (day/evening/night) $L_{A\,eq,T}$; and/or
- ambient noise level (day/evening/night) $L_{A\,eq,T}$, as appropriate;
- vibration data that may be expressed in terms of the peak particle velocity (ppv) in mm s^{-1} or the vibration dose value (VDV) in m $s^{-1.75}$.

For noise these are given the meaning as defined in BS4142:1997 *Method for rating industrial noise affecting mixed residential and industrial areas*, and to which reference should be made for a full description. For vibration, the appropriate standard is BS6472:1992 " Evaluation of human exposure to vibration in buildings "1 to 80 Hz". In very general terms "background" is taken to be the equivalent continuous A-weighted noise remaining when the source under investigation is not operation averaged over a representative time period, T. The "ambient" level is the equivalent continuous A-weighted combination of all noise sources far and distant, including the source under investigation and "specific noise" is the equivalent continuous A-weighted noise level produced by the source under investigation as measured at a selected assessment point. Both are averaged over a time period, T. BS4142 gives advice on the appropriate reference periods. "Worst case" situations and impulsive or tonal noise should be accounted for separately and not "averaged out" over the measurement period.

4. Provide *details of any environmental noise measurement surveys,* modelling or any other noise measurements undertaken relevant to the environmental impact of the site, identifying:
   - the purpose/context of the survey;
   - the locations where measurements were taken;
   - the source(s) investigated or identified;
   - the outcomes.

5. Identify any specific local issues and proposals for improvements.

6. Describe the current or proposed position with regard to the techniques below, any in Reference 20 or any others that are pertinent to the installation.

7. Demonstrate that the proposals are BAT by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the *A1 Guide for Applicants*) or alternative measures.

Indicative BAT requirements

1. The Operator should employ basic good practice measures for the control of noise, including adequate maintenance of any parts of plant or equipment whose deterioration may give rise to increases in noise (for example, maintenance of bearings, air handling plant, the building fabric as well as specific noise attenuation measures associated with plant, equipment or machinery).

2. The Operator should also employ such other noise control techniques to ensure that the noise from the installation does not give rise to reasonable cause for annoyance, in the view of the Regulator and, in particular, should justify where either Rating Levels ($L_{Aeq,T}$) from the installation exceed the numerical value of the Background Sound Level ($L_{A90,T}$), or the absolute levels of 50dB L_{Aeq} by day or 45 by night are exceeded. Reasons why these levels may be exceeded in certain circumstances are given in Reference 20.

3. In some circumstances "creeping background" (see Reference 20) may be an issue. Where this has been identified in pre application discussions or in previous discussions with the local authority, the Operator should employ such noise control techniques as are considered appropriate to minimise problems to an acceptable level within the BAT criteria.

Cont.

4. 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. Operators may have a noise management plan as part of their management system. More information on such techniques is given in Part 2 of Reference 20.

2.10 Monitoring

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

Application form Question 2.10

Describe the proposed measures for monitoring emissions, including any environmental monitoring, and the frequency, measurement methodology and evaluation procedure proposed.

With the Application the Operator should:

1. Describe the current or proposed position with regard to the monitoring requirements below or any others that are pertinent to the installation for emissions monitoring, environmental monitoring, process monitoring (where environmentally relevant) and monitoring standards employed.

2. Provide, in particular, the information described in requirement 15 on page 85 .

3. Provide justifications for not using any of the monitoring requirements described.

4. Identify shortfalls in the above information that the Operator believes require longer-term studies to establish.

Emissions monitoring

The following monitoring parameters and frequency are normally appropriate in this sector. Generally, monitoring should be undertaken during commissioning, start-up, normal operation and shut-down unless the Regulator agrees that it would be inappropriate to do so.

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

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

Monitoring and reporting of emissions to water and sewer

1. Monitoring of process effluents released to controlled waters and sewers should include at least:

Parameter	Monitoring frequency
Flow rate	Continuous and integrated daily flow rate
pH	Continuous
Temperature	Continuous
COD/BOD	Flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages
Turbidity	Continuous
Oil	Weekly analysis

NB - other parameters specifically limited in the Permit should be monitored. These are most likely to include any or all of: heavy metals (individually or total), chlorine, chloride, fluoride, phenol, formaldehyde, ammoniacal nitrogen, sulphate. The appropriateness of the above frequencies will vary depending upon the sensitivity of the receiving water and should be proportionate to the scale of the operations.

2. The Operator should also have a fuller analysis carried out covering a broad spectrum of substances to establish that all relevant substances have been taken into account when setting the release limits. This should cover the substances listed in Schedule 5 of the Regulations unless it is agreed with the Regulator that they are not applicable. This should normally be done at least annually.

3. Any substances found to be of concern, or any other individual substances to which the local environment may be susceptible and upon which the operations may impact, should also be monitored more regularly. This would particularly apply to the common pesticides and heavy metals. Using composite samples is the technique most likely to be appropriate where the concentration does not vary excessively.

Emissions monitoring (cont.)

4. In some sectors there may be releases of substances that are more difficult to measure and whose capacity for harm is uncertain, particularly when combined with other substances. "Whole effluent toxicity" monitoring techniques can therefore be appropriate to provide direct measurements of harm, for example, direct toxicity assessment. Some guidance on toxicity testing is available (Reference 21) and the Regulator will be providing further guidance in due course. Except in special circumstances, toxicity testing should await that guidance.

Monitoring and reporting of emissions to air

5. Continuous monitoring would be expected where the releases are significant and where it is needed to maintain good control, that is from the melting furnace.

6. Gas flow should be measured, or otherwise determined, to relate concentrations to mass releases.

7. To relate measurements to reference conditions, the following will need to be determined and recorded, at the same time as the other required parameters are being measured:
   - temperature and pressure;
   - oxygen, where the emissions are the result of a combustion process;
   - water vapour content, where the emissions are the result of a combustion process or any other wet gas stream. It would not be needed where the water vapour content is unable to exceed 3% v/v or where the measuring technique measures the other pollutants without removing the water.

8. The measurement of emissions can be affected by several factors, some of which are particularly important in glass melting processes. These include:
   - waste gas temperature;
   - size distribution of dust;
   - waste gas velocity;
   - waste gas moisture;
   - gaseous and particulate form of pollutants;
   - sampling time;

   Waste gas temperature: The flue gas temperature from the furnace can vary substantially (generally from 100 to 850 °C at the stack), depending on the heat recovery systems and the abatement technique applied. Measurement errors due to the waste gas temperature should be minimised by:
   - use of appropriate filters and probes for dust measurements
   - appropriate conditioning of the filters before use at high temperatures
   - use of heated probes and filters at low waste gas temperatures.

   Size distribution of dust: The particle diameter of dust generated by the melting process is normally very small (less than 1μm, and generally 0.02 – 0.5μm). During sampling the particles easily agglomerate and, when alkaline filtering materials are used, tend to react with the acid gaseous substances present in the flue gas. In order to avoid this, chemically inert filters should be selected for sampling. When particulate matter is measured continuously, the fine particles can be difficult to remove from the optical parts of the measuring equipment, leading to erroneous data. A suitable cleaning system should be applied.

   Waste gas velocity: Particulate measurements should be carried out isokinetically. The geometry of the duct and the position of the sampling point should be selected in order to allow a correct measurement of the flue gas velocity.

   Waste gas moisture: The presence of high percentages of water in the waste gases is very common in the case of oxy-fuel melting and air/gas furnaces when water is used as coolant prior to abatement equipment. The determination of the gas dew point should be carried out in order to avoid condensation during sampling. Gaseous pollutants should be measured using heated probes any time there is risk of condensation during sampling, especially in SO_3 rich flue gases. This is also the case for some downstream processes employing wet scrubbers, for example continuous filament glass fibre. Where water condensation does occur, the resulting liquid should be checked to determine the possible absorption of gaseous pollutants, for example, oxides of sulphur.

Gaseous and particulate form of pollutants: Some pollutants can be released into the atmosphere in both gaseous and particulate form. For example, some substances from the melting process such as certain boron compounds, selenium, arsenic and mercury. In these cases the sampling train should be equipped with a combined system for the simultaneous collection of both particulate and gaseous compounds.

Sampling time: In the case of regenerative furnaces, in addition to the standard procedures which require an adequate sampling time for collecting a representative sample, a good practice should take into consideration the reversal cycle of the regenerators. Emissions from the melting process can vary substantially with the temperature cycle of the chambers. In order to carry out measurements with comparable results the sampling time should cover an even number of firing cycles. This can also be an issue with cleaning cycles on abatement equipment.

In batch processes the nature of the emissions will vary through the production cycle. In particular, peak emissions will be generated during the period after charging until melting has been completed. The emissions generated during the post melt phase will be greatly reduced in comparison. If an assessment of worst case scenario for emissions is required then monitoring should take place during the period after charging until melting is complete.

REQUESTING SPECIFIC COMMENT/FEEDBACK ON THIS ISSUE…

9. The following Table indicates the main pollutants which should be considered for emissions monitoring:

Parameter	**Sub sector**				
	Cont. filament glass fibre	**Mineral Wool**	**Ceramic Fibre**	**Frits**	**Optical fibre**
DUST					
- materials handling	✓#	✓#	✓#	✓#	✓#
- melting	✓#	✓#	✓#	✓#	
- vapour deposition					✓#
- downstream activities	✓#	✓#	✓#	✓#	
FIBRES – downstream activities			✓		
CRYSTALLINE SILICA – materials handling	✓	✓	✓	✓	
HEAVY METALS					
- materials handling				✓	
- melting				✓	
CO – melting	✓#	✓#	✓	✓#	
NOx					
- melting	✓#	✓#	✓	✓#	
- downstream activities		✓(curing)			
SOx – melting	✓#	✓#	✓	✓#	
HF					
- melting	✓#	✓#	✓	✓#	
- vapour deposition					✓#
HCl					
- melting	✓#	✓#	✓	✓#	
- vapour deposition					✓#
CHLORINE – vapour deposition					✓#
GASEOUS BORON COMPOUNDS – melting	✓	✓		✓	

Parameter	Sub sector				
	Cont. filament glass fibre	Mineral Wool	Ceramic Fibre	Frits	Optical fibre
H_2S – melting		✓#	✓		
VOC – downstream activities	✓#	✓#	✓		✓
FORMALDEHYDE – downstream activities	✓	✓			
AMMONIA – downstream activities	✓	✓			
PHENOLS – downstream activities		✓			
AMINES – downstream activities		✓			

NB - other parameters specifically limited in the Permit should be monitored. Monitoring frequency will vary depending upon the sensitivity of the receiving environment and should be proportionate to the scale of the operations.

in the Table indicates the parameters considered a priority for continuous monitoring.

For batch processes, continuous monitoring of the process temperature is required, to determine melt and post-melt phases – see section 3.2.6.

REQUESTING SPECIFIC COMMENT/FEDBACK

10. Where appropriate, periodic visual and olfactory assessment of releases should be undertaken to ensure that all final releases to air should be essentially colourless, free from persistent trailing mist or fume and free from droplets.

Monitoring and reporting of waste emissions

11. For waste emissions, 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;
    - where waste is disposed of directly to land, for example, sludge spreading or an on-site landfill, a programme of monitoring should be established that takes into account the materials, potential contaminants and potential pathways from the land to groundwater surface water or the food chain.

Environmental monitoring (beyond the installation)

Environmental monitoring

12. The Operator should consider the need for environmental monitoring to assess the effects of emissions to controlled water, groundwater, air or land, or emissions of noise or odour.

    Environmental monitoring may be required, for example, when:
    - there are vulnerable receptors;
    - the emissions are a significant contributor to an Environmental Quality Standard (EQS) that may be at risk;
    - the Operator is looking for departures from standards based on lack of effect on the environment;
    - to validate modelling work.

    The need should be considered for:
    - groundwater, where it should be designed to characterise both quality and flow and take into account short- and long-term variations in both. Monitoring will need to take place both up-gradient and down-gradient of the site;
    - surface water, where consideration will be needed for sampling, analysis and reporting for upstream and downstream quality of the controlled water;
    - air, including odour;
    - land contamination, including vegetation, and agricultural products;
    - assessment of health impacts;
    - noise.

Where environmental monitoring is needed, the following should be considered in drawing up proposals:

- determinands to be monitored, standard reference methods, sampling protocols;
- monitoring strategy, selection of monitoring points, optimisation of monitoring approach;
- determination of background levels contributed by other sources;
- uncertainty for the employed methodologies and the resultant overall uncertainty of measurement;
- 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 for the Regulator.

Guidance on air quality monitoring strategies and methodologies can be found in Technical Guidance Notes M8 and M9 (see Reference 21), for noise (see Reference 20) and for odour (see Reference 23).

Monitoring of process variables

Monitoring process variables

13. Some process variables will have potential environmental impact and these should be identified and monitored as appropriate. Examples might be:
    - raw materials monitoring for contaminants where contaminants are likely and there is inadequate supplier information (see Section 2.2.1);
    - plant efficiency where it has an environmental relevance;
    - abatement equipment performance (e.g. bag filter pressure drop);
    - energy consumption across the plant and at individual points-of-use in accordance with the energy plan. Frequency – normally continuous and recorded;
    - fresh water use across the activities and at individual points-of-use should be monitored as part of the water-efficiency plan (see Section 2.2.3). Frequency – continuous and recorded.

Monitoring standards (Standard Reference Methods)

Monitoring standards

Equipment standards

Equipment standards MCERTS

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. Performance standards have been published for continuous emissions monitoring systems (CEMs), and other MCERTS standards are under development to cover manual stack emissions monitoring, portable emissions monitoring equipment, ambient air-quality monitors, water monitoring instrumentation, data acquisition and Operators' own arrangements, such as for installation, calibration and maintenance of monitoring equipment, position of sampling ports and provision of safe access for manual stack monitoring.

14. As far as possible, Operators should ensure their monitoring arrangements comply with the requirements of MCERTS where available, for example using certified instruments and equipment, and using a registered stack testing organisation and the like. Where the monitoring arrangements are not in accordance with MCERTS requirements, the Operator should provide justification and describe the monitoring provisions in detail. See the Environment Agency Website (Reference 21) for listing of MCERTS equipment.

15. The following should be described in the application, indicating which monitoring provisions comply with MCERTS requirements or for which other arrangements have been made:
    - monitoring methods and procedures (selection of Standard Reference Methods);
    - justification for continuous monitoring or spot sampling;
    - reference conditions and averaging periods;
    - measurement uncertainty of the proposed methods and the resultant overall uncertainty;
    - criteria for the assessment of non-compliance with Permit limits and details of monitoring strategy aimed at demonstration of compliance;
    - reporting procedures and data storage of monitoring results, record keeping and reporting intervals for the provision of information to the Regulator;
    - procedures for monitoring during start-up and shut-down and abnormal process conditions;
    - drift correction calibration intervals and methods;
    - the accreditation held by samplers and laboratories or details of the people used and the training/competencies.

Standards for sampling and analysis

BREF: Monitoring REF document in preparation.

Sampling and analysis standards

16. The analytical methods given in Appendix 1 should be used. In the event of other substances needing to be monitored, standards should be used in the following order of priority:
    - Comité Européen de Normalisation (CEN);
    - British Standards Institution (BSI);
    - International Standardisation Organisation (ISO);
    - United States Environmental Protection Agency (US EPA);
    - American Society for Testing and Materials (ASTM);
    - Deutches Institute für Normung (DIN);
    - Verein Deutcher Ingenieure (VDI);
    - Association Française de Normalisation (AFNOR).

Further guidance on standards for monitoring gaseous releases relevant to IPC/IPPC is given in the *Technical Guidance Note 4 (Monitoring)* (see Reference 21). A series of updated Guidance Notes covering this subject is currently in preparation. This guidance specifies manual methods of sampling and analysis that 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.

If in doubt the Operator should consult the Regulator.

Monitoring timescales

17. The Operator should complete any detailed studies required into monitoring needs (see item 4 at the beginning of this monitoring section) as an improvement condition to a timescale to be agreed with the Regulator but in any case within the timescale given in Section 1.1

18. For existing activities, the above techniques should be programmed for implementation within the same timescale.

2.11 Decommissioning

The IPPC application requires the preparation of a site report whose purpose, as described in more detail in References 4 and 5, is to provide a point of reference against which later determinations can be made of whether there has been any deterioration of the site and information on the vulnerability of the site.

Application form
Question 2.11

Describe the proposed measures, upon definitive cessation of activities, to avoid any pollution risk and return the site of operation to a satisfactory state (including, where appropriate, measures relating to the design and construction of the installation).

With the Application the Operator should:

1. Supply the site report.
2. Describe the current or proposed position with regard to the techniques below or any others that are pertinent to the installation.
3. For existing activities, identify shortfalls in the above information that the Operator believes require longer-term studies to establish.

Indicative BAT requirements

1. **Operations during the IPPC Permit**
Operations during the life of the IPPC Permit should not lead to any deterioration of the site if the requirements of the other sections of this and the specific-sector notes are adhered to. Should any instances arise which have, or might have, impacted on the state of the site, the Operator should record them along with any further investigation or ameliorating work carried out. This will ensure that there is a coherent record of the state of the site throughout the period of the IPPC Permit. This is as important for the protection of the Operator as it is for the protection of the environment. Any changes to this record should be submitted to the Regulator.

2. **Steps to be taken at the design-and-build stage of the activities**
Care should be taken at the design stage to minimise risks during decommissioning. For existing installations, where potential problems are identified, a programme of improvements should be put in place to a timescale agreed with the Regulator. Designs should ensure that:
   - underground tanks and pipework are avoided where possible (unless protected by secondary containment or a suitable monitoring programme);
   - there is provision for the draining and clean-out of vessels and pipework prior to dismantling;
   - lagoons and landfills are designed with a view to their eventual clean-up or surrender;
   - insulation is provided that is readily dismantled without dust or hazard;
   - materials used are recyclable (having regard for operational or other environmental objectives).

3. **The site-closure plan**
A site closure plan should be maintained to demonstrate that, in its current state, the installation can be decommissioned to avoid any pollution risk and return the site of operation to a satisfactory state. The plan should be kept updated as material changes occur. Common sense should be used in the level of detail, since the circumstances at closure will affect the final plans. However, even at an early stage, the closure plan should include:
   - either the removal or the flushing out of pipelines and vessels where appropriate and their complete emptying of any potentially harmful contents;
   - plans of all underground pipes and vessels;
   - the method and resource necessary for the clearing of lagoons;
   - the method of ensuring that any on-site landfills can meet the equivalent of surrender conditions;
   - the removal of asbestos or other potentially harmful materials unless agreed that it is reasonable to leave such liabilities to future owners;

Cont.

- methods of dismantling buildings and other structures, see Reference 25 which gives guidance on the protection of surface and groundwater at construction and demolition-sites;
- testing of the soil to ascertain the degree of any pollution caused by the activities and the need for any remediation to return the site to a satisfactory state as defined by the initial site report.

(Note that radioactive sources are not covered by this legislation, but decommissioning plans should be co-ordinated with responsibilities under the Radioactive Substances Act 1993.)

For existing activities, the Operator should complete any detailed studies (see Application item 3 above), and submit the site-closure plan as an improvement condition to a timescale to be agreed with the Regulator but in any case within the timescale given in Section 1.1

2.12 Installation-wide issues

In some cases it is possible that actions that benefit the environmental performance of the overall installation will increase the emissions from one Permit-holder's activities. For example, taking treated effluent as a raw water supply will probably slightly increase emissions from that activity, but could dramatically cut the total emissions from the whole installation.

Application form
Question 2.12

Where you are not the only Operator of the installation, describe the proposed techniques and measures (including those to be taken jointly by yourself and other Operators) for ensuring the satisfactory operation of the whole installation.

With the Application the Operator should:

1. Where there are a number of separate Permits for the installation (particularly where there are different Operators), identify any installation-wide issues and opportunities for further interactions between the Permit-holders whereby the performance of the overall installation may be improved; and in particular,
2. Describe the current or proposed position with regard to the techniques below, or any others that are pertinent to the installation.

Indicative BAT requirements

BAT across the whole installation

The possibilities will be both sector- and site-specific, and include:

1. Communication procedures between the various Permit-holders; in particular those needed to ensure that the risk of environmental incidents is minimised.
2. Benefiting from the economies of scale to justify the installation of a CHP plant.
3. The combining of combustible wastes to justify a combined waste-to-energy/CHP plant.
4. The waste from one activity being a possible feedstock for another.
5. The treated effluent from one activity being of adequate quality to be the raw water feed for another activity.
6. The combining of effluent to justify a combined or upgraded effluent-treatment plant.
7. The avoidance of accidents from one activity that may have a detrimental knock-on effect on the neighbouring activity.
8. Land contamination from one activity affecting another – or the possibility that one Operator owns the land on which the other is situated.

3 EMISSION BENCHMARKS

3.1 Emissions inventory and benchmark comparison

Application form Question 3.1	***Describe the nature, quantities and sources of foreseeable emissions into each medium (which will result from the techniques proposed in Section 2).***

With the Application the Operator should:

1. Provide a table of significant emissions of substances (except noise, vibration, odour and heat which are covered in their respective sections) that will result from the proposals in Section 2 and should include, preferably in order of significance:
   - substance (where the substance is a mixture, for example, VOCs or COD, separate identification of the main constituents or inclusion of an improvement proposal to identify them);
   - source, including height, location and efflux velocity;
   - media to which it is released;
   - any relevant EQS or other obligations;
   - benchmark;
   - proposed emissions normal/max expressed, as appropriate (see Section 3.2), for:
     - mass/unit time;
     - concentration;
     - annual mass emissions.
   - statistical basis (average, percentile etc.);
   - notes covering the Operators confidence in his ability to meet the benchmark values;
   - if intermittent, the appropriate frequencies;
   - plant loads at which the data is applicable;
   - whether measured or calculated (the method of calculation should be provided).

   The response should clearly state whether the emissions are current emission rates or those planned following improvements, and should cover emissions under both normal and abnormal conditions for:
   - point-source emissions to surface water, groundwater and sewer;
   - waste emissions (refer to Sections 2.5 and 2.6 – Waste Management);
   - point-source emissions to air;
   - significant fugitive emissions to all media, identifying the proportion of each substance released that is due to fugitives rather than point-source releases;
   - abnormal emissions from emergency relief vents, flares and the like;
   - indirect and direct emission of carbon dioxide associated with energy consumed or generated.

   Emissions of carbon dioxide associated with energy use should be broken down by energy type and, in the case of electricity, by source, for example, public supply, direct supply or on-site generation. Where energy is generated on-site, or from a direct (non-public) supplier, the Operator should specify and use the appropriate factor. Standard factors for carbon dioxide emissions are provided in the *Energy Efficiency Guidance Note* (Reference 14).

   Where VOCs are released, the main chemical constituents of the emissions should be identified. The assessment of the impact of these chemicals in the environment will be carried out as in response to Section 4.1.

   For waste, emissions relate to any wastes removed from the installation, or disposed of at the installation under the conditions of the Permit, for example, landfill. Each waste should have its composition determined and the amounts expressed in terms of cubic metres or tonnes per month. A suitable table on which to record this information is provided in the electronic version of this Guidance Note.

2. Compare the emissions with the benchmark values given in the remainder of this Section.

3. Where the benchmarks are not met, revisit the responses made in Section 2 as appropriate (see Section 1.2) and make proposals for improvements or justify not doing so.

3.2 Emission benchmarks

Introduction to emission benchmarks

Guidance is given below on release concentrations or mass release rates achievable for key substances using the best combination of techniques. These BAT-based benchmarks are not mandatory release limits and reference should be made to Section 1 and the *Guide for Applicants* regarding their use.

3.2.1 Emissions to air associated with the use of BAT

The emissions quoted below are daily averages based upon continuous monitoring during the period of operation. See section 3.2.6 for the standard conditions that should be applied. Care should always be taken to convert benchmark and proposed releases to the same reference conditions for comparison. To convert measured values to reference conditions, see Technical Guidance Note M2 (Reference 21) for more information

Limits in Permits may be set for mean or median values over long or short periods. The periods and limits selected should reflect:

- the manner in which the emission may impact upon the environment;
- likely variations which will arise during operation within BAT;
- possible failure modes and their consequences;
- the capabilities of the monitoring and testing system employed.

Where emissions are expressed in terms of concentrations and where continuous monitors are employed, it is recommended that limits are defined such that:

- not more than one calendar monthly average during any rolling twelvemonth period shall exceed the benchmark value by more than 10%;
- not more than one half hour period* during any rolling 24 hour period shall exceed the benchmark value by more than 50%.

* for the purpose of this limit half hourly periods commence on the hour and the half hour.

Where spot tests are employed:

- the half hour limit above shall be applied over the period of the test;
- the mean of three consecutive tests taken during a calendar year shall not exceed the benchmark value by more than 10%.

3.2.2 Emissions to water associated with the use of BAT

Wastewater treatment systems can maximise the removal of metals using 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.

Where automatic sampling systems are employed, limits may be defined such that:

- not more than 5% of samples shall exceed the benchmark value.

Where spot samples are taken:

- no spot sample shall exceed the benchmark value by more than 50%.

Examples of emissions to water associated with the use of BAT:

3.2.3 Standards and obligations

In addition to meeting the requirements of BAT, there are other national and international standards and obligations that must either be safeguarded through the IPPC Permit or, at least, taken into account in setting Permit conditions. This is particularly the case for any EC based EQSs.

EC-based EQ standards

IPPC: A Practical Guide (see Reference 4) explains how these should be taken into account and contains an annex listing the relevant standards. (See Appendix 2 for equivalent legislation in Scotland and Northern Ireland). They can be summarised as follows.

Air quality

- Statutory Instrument 1989 No 317, *Clean Air, The Air Quality Standards Regulations 1989* gives limit values in air for nitrogen dioxide (any emission from the process should not result in a breach of this standard beyond the site boundary), sulphur dioxide and suspended particulates.

- Statutory Instrument 1997 No 3043, *Environmental Protection, The Air Quality Regulations 1997*.
- Statutory Instrument 2000 No.928, *Air Quality (England) Regulations 2000* gives air quality objectives to be achieved by:
  - 2005 for nitrogen dioxide;
  - 2004 for SO_2 and PM10;
  - 2003 for CO, 1,3 butadiene and benzene;
  - in two stages for lead by 2004 and 2008 respectively.

Water quality

- Directive 76/464/EEC on Pollution Caused by Dangerous Substances Discharged to Water contains two lists of substances. List I relates to the most dangerous, and standards are set out in various daughter Directives. List II substances must also be controlled. Annual mean concentration limits for receiving waters for List I substances can be found in SI 1989/2286 and SI 1992/337 the Surface Water (Dangerous Substances Classification) Regulations. Values for List II substances are contained in SI 1997/2560 and SI 1998/389. Daughter Directives cover EQS values for mercury, cadmium, hexachlorocyclohexane, DDT, carbon tetrachloride, pentachlorophenol, aldrin, dieldrin, endrin, isodrin, hexachlorobenzene, hexachlorobutadiene, chloroform,1,2-dichloroethane, trichloroethane, perchloroethane and trichlorobenzene.
- Other waters with specific uses have water-quality concentration limits for certain substances. These are covered by the following Regulations:
  - SI 1991/1597 Bathing Waters (Classification) Regulations;
  - SI 1992/1331 and Direction 1997 Surface Waters (Fishlife) (Classification) Regulations;
  - SI 1997/1332 Surface Waters (Shellfish) (Classification) Regulations;
  - SI 1996/3001 The Surface Waters (Abstraction and Drinking Water) (Classification) Regulations.

Future likely changes include:

- Some air-quality and water-quality standards may be replaced by new ones in the near future.
- The Solvents Directive on the limitation of emissions of VOCs due to the use of organic solvents in certain activities and installations.

Other standards and obligations

Those most frequently applicable to most sectors are:

- Hazardous Waste Incineration Directive;
- Waste Incineration Directive;
- Large Combustion Plant Directive;
- Reducing Emissions of VOCs and Levels of Ground Level Ozone: a UK Strategy (published by the Department of the Environment in October 1993. It sets out how the Government expects to meet its obligations under the UNECE VOCs Protocol to reduce its emissions by 30% (based on 1988 levels) by 1999, including the reductions projected for the major industrial sectors);
- Water Quality Objectives – assigned water quality objectives to inland rivers and water courses (ref. Surface (Rivers Ecosystem) Classification);
- The UNECE convention on long-range transboundary air pollution (negotiations are now underway which could lead to a requirement further to reduce emissions of NO*x* and VOCs. A requirement to further reduce SO2 emissions *from all sources* has been agreed. The second Sulphur protocol (Oslo, 1994) obliges the UK to reduce SO2 emissions by 80% (based on 1980 levels) by 2010);
- The Montreal Protocol;
- The Habitats Directive (see Section 4.3).
- Sulphur Content of Certain Liquid Fuels Directive 1999/32/EC (from 1 January 2003, the sulphur content of heavy fuel oil must not exceed 1% except when it is burnt in plants fitted with SO_2 abatement equipment. Sulphur levels in gas oil must not exceed 0.2% from 1 July 2000, and 0.1% from the start of 2008).

3.2.4 Units for benchmarks and setting limits in Permits

Releases can be expressed in terms of:

- "**concentration**" (for example mg/l or mg/m^3), which is a useful day-to-day measure of the effectiveness of any abatement plant and is usually measurable and enforceable The total flow must be measured/controlled as well;

- "**specific mass release**" (for example, kg/ tproduct or input or other appropriate parameter), which is a measure of the overall environmental performance of the plant (including the abatement plant) compared with similar plants elsewhere;
- "**absolute mass release**" (for example, kg/hr, t/yr), which relates directly to environmental impact.

When endeavouring to reduce the environmental impact of an installation, its performance against each of these levels should be considered, as appropriate to the circumstances, in assessing where improvements can best be made.

When setting limits in Permits, the most appropriate measure will depend on the purpose of the limit. It may also be appropriate to use surrogate parameters, which reflect optimum environmental performance of plant as the routine measurement, supported by less frequent check-analyses on the final concentration. Examples of surrogate measures would be the continuous measurement of conductivity (after ion-exchange treatment) or total carbon (before a guard-column in activated carbon treatment) to indicate when regeneration or replacement is required.

The emission level figures given in this chapter are based on average figures, not on maximum, short-term peak values, which could be expected to be higher. The emission levels given are based on a typical averaging period of not less than 30 minutes and not greater than 24 hours.

3.2.5 Statistical basis for benchmarks and limits in Permits

Conditions in Permits can be set with percentile, mean or median values over annual, monthly or daily periods, which reflect probable variation in performance. In addition, absolute maxima can be set.

Where there are known failure modes, which will occur even when applying BAT, limits in Permits may be specifically disapplied, but with commensurate requirements to notify the Regulator and to take specific remedial action.

For water: UK benchmarks or limits are most frequently 95 percentile concentrations or absolute concentrations, (with flow limited on a daily average or maximum basis).

For air: benchmarks or limits are most frequently expressed as daily averages or, typically 95 percent of hourly averages.

3.2.6 Reference conditions for releases to air

The reference conditions of substances in releases to air from point-sources are:

- For combustion gases: dry, temperature 0 °C (273K), pressure 101.3 kPa, 8% oxygen by volume (continuous melters), 13% oxygen by volume (discontinuous melters).
- For oxy-fuel fired systems the expression of the emissions corrected to 8% oxygen is of little value, and emissions from these systems should be discussed in terms of mass.
- For other gases (including emissions from curing and drying ovens without tail gas incineration): temperature 0 °C (273K), pressure 101.3 kPa with no correction for oxygen or water vapour concentration.

These reference conditions relate to the benchmark release levels given in this Note and care should always be taken to convert benchmark and proposed releases to the same reference conditions for comparison. The Permit may employ different reference conditions if they are more suitable for the process in question.

For batch melting, the nature of the oxygen concentrations changes significantly through the whole cycle. Emissions should be corrected to 13% oxygen during the melt phase of the cycle, but no correction for oxygen should take place once melting has finished (the transition between melting and post melting can be defined by temperature changes.

REQUESTING SPECIFIC FEEDBACK/COMMENTS

To convert measured values to reference conditions, see *Technical Guidance Note M2* (Reference 21) for more information.

3.3 Benchmark release levels to air for continuous filament glass fibre

Refer to Section 3.2.3 for details of other applicable standards and obligations. Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.

BREF section 5.5

Activity/ Substance	BREF Benchmark release level (mg/Nm^3)	Action level	Recommended Permit level
MELTING Particulate	5 – 30 (notes 1, 6)	5	20
Oxides of nitrogen (expressed as NO_2) With oxy-fuel firing	300 – 700 (note 7) 100 - 500		
Oxides of sulphur (expressed as SO_2) (note 2) Natural gas firing Oil firing	 200 – 800 (notes 1, 3) 500 – 1000 (note 1)		
Chlorides (expressed as hydrogen chloride) (note 4)	<30		
Fluorides (expressed as hydrogen fluoride) (note 4)	5 – 15		
Metals (groups 1 & 2) (note 4,5)	<5		
Metals (group 1) (note 4,5)	<1		
DOWNSTREAM PROCESSING Particulate	5 - 20		
Total VOC	5 – 50		

NOTES

1. If dust is not recycled to the furnace then the maximum figure will be lower.
2. Assumes secondary abatement of dust, with dry or semi-dry acid gas scrubbing where appropriate.
3. The upper figure is where sulphates are used as refining agents.
4. Assumes primary measures or acid gas scrubbing combined with dust abatement.
5. Group 1 metals (and their compounds): arsenic, cobalt, nickel, selenium, chromium VI. Group 2 metals (and their compounds): antimony, lead, chromium III, copper, manganese, vanadium, tin. The benchmark release levels include metals present in gas phase and bound to dust (Bref p.224).
6. Previous IPC benchmark upper limit.
7. Previous IPC benchmark lower limit.

3.4 Benchmark release levels to air for mineral wool

Refer to Section 3.2.3 for details of other applicable standards and obligations. Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.

BREF section 5.8

Activity/ Substance	BREF Benchmark release level (mg/Nm^3)	Action level	Recommended Permit value
MELTING Particulate	 5 – 30 (note 1)	 5	 30
Oxides of nitrogen (expressed as NO_2) Glass wool Glass wool with oxy fuel firing Stone wool	 500 – 700 300 (note 8) <200		
Oxides of sulphur (expressed as SO_2) <u>Glass wool</u> Gas firing or electrical heating Oil firing	 <50 300 – 1000		
Oxides of sulphur (expressed as SO2) <u>Stone wool</u> Stone charging Charging with cement bound briquettes	 <200 – 600 (notes 2, 3) 400 – 1400 (note 3)		
Chlorides (expressed as hydrogen chloride)	<30		
Fluorides (expressed as hydrogen fluoride)	<5		
Hydrogen sulphide	<5		
Carbon monoxide	<200		
Metals (groups 1 & 2) (note 4)	<5		
Metals (group 1) (note 4)	<1		
FORMING AREA AND COMBINED FORMING AND CURING Particulate	 20 – 50 (note 5)		
Phenol	5 – 15 (note 6)		
Formaldehyde	5 – 10 (note 6)		
Ammonia	30 – 65 (note 6)		
Amines	<5 (notes 6, 7)		
Total VOC	10 – 50 (note 6)		
CURING OVEN (only) <u>Glass wool</u> Particulate Phenol Formaldehyde Ammonia Amines Total VOC	 20 – 50 5 – 10 5 – 10 30 – 65 <5 (note 7) 10 – 50		
<u>Stone wool</u> Particulate	 5 – 30		

Activity/ Substance	BREF Benchmark release level (mg/Nm^3)	Action level	Recommended Permit value
Phenol	<5		
Formaldehyde	<5		
Ammonia	<20 – 65		
Amines	<5 (note 7)		
Total VOC	<10		
COOLING	Emissions similar to those from the forming area.		
MACHINING/ PACKAGING			
Particulate	<5		

NOTES

1 Assumes use of EP or fabric filter. For glass wool production, the use of dry or semi-dry scrubbing is not generally necessary.

2 The lower figure would be achievable with dry scrubbing.

3 Achievable releases depend on priorities at the installation. If waste minimisation is a priority then release levels are likely to be higher. Where the priority is for reduction of SOx emissions, the use of acid gas scrubbing may represent BAT and lower release levels will be achievable.

4 Group 1 metals (and their compounds): arsenic, cobalt, nickel, selenium, chromium VI. Group 2 metals (and their compounds): antimony, lead, chromium III, copper, manganese, vanadium, tin. The benchmark release levels include metals present in gas phase and bound to dust (Bref p.224).

5 Where a wet EP or stone wool filter is used emissions would be expected towards the lower end of the range.

6 Where a packed bed scrubber is used, gaseous emissions towards the lower end of the range would be expected.

7 Based on the use of amine free binders and non-amine catalysed resins.

8 Previous IPC benchmark.

3.5 Benchmark release levels to air for ceramic fibre

Refer to Section 3.2.3 for details of other applicable standards and obligations. Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.

BREF section 5.9

Activity/ Substance	BREF Benchmark release level (mg/Nm^3)	Action level	Recommended permit value
MELTING Particulate	<10		
Oxides of nitrogen (expressed as NO_2)	<0.1 – 0.5 kg/tonne of melt		
Oxides of sulphur (expressed as SO_2)	<0.1 – 0.5 kg/tonne of melt		
Chlorides (expressed as hydrogen chloride)	<10		
Fluorides (expressed as hydrogen fluoride)	<5		
Metals (groups 1 & 2) (note 1)	<5		
Metals (group 1) (note 1)	<1		
DOWNSTREAM PROCESSING Particulate	5		
Ceramic fibre (note 2)	1		
Total VOC	10 – 20		

NOTES

1. Group 1 metals (and their compounds): arsenic, cobalt, nickel, selenium, chromium VI. Group 2 metals (and their compounds): antimony, lead, chromium III, copper, manganese, vanadium and tin. The benchmark release levels include metals present in gas phase and bound to dust (Bref p.224).
2. A fibre in this context is defined as an object of length greater than 5 µm, breadth less than 3 µm and having a length/breadth ratio greater than 3:1.

3.6 Benchmark release levels to air for frits

Refer to Section 3.2.3 for details of other applicable standards and obligations. Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.

BREF section 5.10

Activity/ Substance	BREF Benchmark release level (mg/Nm^3)	Action Level	Recommended Permit Value
MELTING Particulate	5 – 20 (note 4)	5	20
Oxides of nitrogen (expressed as NO_2)	300 – 700 (note 5)		
Oxides of sulphur (expressed as SO_2) Oil firing	<200 500 – 1000 (note 1)		
Chlorides (expressed as hydrogen chloride) (note 4)	<10		
Fluorides (expressed as hydrogen fluoride) (note 4)	<5 (note 2)		
Metals (groups 1 & 2) (note 3)	<5		
Metals (group 1) (note 3)	<1		
DOWNSTREAM PROCESSING Particulate	5 – 10		
Metals (groups 1 & 2) (note 3)	<5		

NOTES

1. Where oil firing is used or there are significant levels of sulphate in the batch.
2. Where batch materials contain significant levels of fluorides, this level is based on the use of an acid gas scrubbing system.
3. Group 1 metals (and their compounds): arsenic, cobalt, nickel, selenium, chromium VI. Group 2 metals (and their compounds): antimony, lead, chromium III, copper, manganese, vanadium and tin. The benchmark release levels include metals present in gas phase and bound to dust (Bref p.224).
4. Previous IPC benchmark upper limit.
5. Previous IPC benchmark + BREF value range.

3.7 Benchmark release levels to air for optical fibre

Refer to Section 3.2.3 for details of other applicable standards and obligations. Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements.

Substance	IPC Benchmark release level (mg/Nm^3)	Action level	Recommended Permit Value
Particulate	20		
Chlorides (expressed as hydrogen chloride)	10		
Fluorides (expressed as hydrogen fluoride)	5		
Chlorine	10		
Total VOC (note 1)	20		

NOTES 1 This release concentration should be aimed for where the release is greater than 100g/hour.

3.8 Benchmark release levels to water (all sectors) (See note 1)

Parameter	Benchmark release level (mg/l)
Suspended solids	<30
Chemical Oxygen Demand (note 2)	100 – 130
Ammonia (kjeldahl)	<10
Sulphate	<1000
Fluoride	15 – 25
Arsenic	<0.3
Antimony	<0.3
Barium	<3.0
Cadmium	<0.05
Chromium (total)	<0.5
Copper	<0.5
Lead	<0.5
Nickel	<0.5
Tin	<0.5
Zinc	<0.5
Phenol	<1.0
Boric acid	2 – 4
PH	6.5 – 9
Mineral oil	<20

NOTES

1 Aqueous emissions from the activities in the glass industry are generally low and not specific to the industry. However, a number of activities can give rise to more significant aqueous emissions. The emission levels given are generally considered to be appropriate to protecting the water environment and are indicative of the emission levels that would be achieved with those techniques generally considered to represent BAT. They do not necessarily represent levels currently achieved within the industry.

2 For the continuous filament glass fibre sector this figure is considered to be 200 mg/l. In general, chemical oxygen demand is quite low and the actual level associated with BAT may depend on the receiving water. If the receiving water is particularly sensitive levels below this figure may be required.

It would be useful to obtain the following information from different processes:

- quantities released of each pollutant;
- where releases are to sewer, whether primary techniques (i.e. precipitation, pH adjustment, coagulation, settlement ponds, filtration) are normally employed;
- how much is, or would be, taken out by primary settlement (i.e. to determine the soluble vs. insoluble fraction).

REQUESTING SPECIFIC COMMENT/FEEDBACK ON THIS ISSUE…

4 IMPACT

4.1 Assessing the impact of emissions on the environment

The Operator should assess that the emissions resulting from the proposals for the activities/ installation will provide a high level of protection for the environment as a whole, in particular having regard to EQSs etc, revisiting the techniques in Section 2 as necessary (see Section 1.2).

Application form
Question 4.1

Provide an assessment of the potential significant environmental effects (including transboundary effects) of the foreseeable emissions.

With the Application the Operator should:

1. Provide a description, including maps as appropriate, of the receiving environment to identify the receptors of pollution. The extent of the area may cover the local, national and international (for example, transboundary effects) environment as appropriate.

2. Identify important receptors, which may include: areas of human population including noise or odour-sensitive areas, flora and fauna (that is, Habitat Directive sites, special areas of conservation, Sites of Special Scientific Interest (SSSI or in Northern Ireland ASSI) or other sensitive areas), soil, water, that is groundwater (water below the surface of the ground in the saturation zone and in direct contact with the ground and subsoil) and watercourses (for example, ditches, streams, brooks, rivers), air, including the upper atmosphere, landscape, material assets and the cultural heritage.

3. Identify the pathways by which the receptors will be exposed (where not self-evident).

4. Carry out an assessment of the potential impact of the total emissions from the activities on these receptors. Reference 6 provides a systematic method for doing this and will also identify where modelling needs to be carried out, to air or water, to improve the understanding of the dispersion of the emissions. The assessment will include comparison (see *IPPC A Practical Guide* (Reference 4) and Section 3.2) with:
   - community EQS levels;
   - other statutory obligations;
   - non-statutory obligations;
   - environmental action levels (EALs) and the other environmental and regulatory parameters defined in Reference 6.

   In particular it will be necessary to demonstrate that an appropriate assessment of vent and chimney heights has been made to ensure that there is adequate dispersion of the minimised emission(s) to avoid exceeding local ground-level pollution thresholds and limit national and transboundary pollution impacts, based on the most sensitive receptor, be it human health, soil or terrestrial ecosystems.

   Where appropriate, the Operator should also recognise the chimney or vent as an emergency emission point and understand the likely behaviour. Process upsets or equipment failure giving rise to abnormally high emission levels over short periods should be assessed. Even if the Applicant can demonstrate a very low probability of occurrence, the height of the chimney or vent should nevertheless be set to avoid any significant risk to health. The impact of fugitive emissions can also be assessed in many cases.

   Consider whether the responses to Sections 2 and 3 and this assessment adequately demonstrate that the necessary measures have been taken against pollution, in particular by the application of BAT, and that no significant pollution will be caused. Where there is uncertainty about this, the measures in Section 2 should be revisited as appropriate to make further improvements.

5. Where the same pollutants are being emitted by more than one permitted activity on the installation, the Operator should assess the impact both with and without the neighbouring emissions.

4.2 Waste Management Licensing Regulations

Application form
Question 4.2

Explain how the information provided in other parts of the application also demonstrates that the requirements of the relevant objectives of the Waste Management Licensing Regulations 1994 have been addressed, or provide additional information in this respect.

In relation to activities involving the disposal or recovery of waste, the Regulators are required to exercise their functions for the purpose of achieving the relevant objectives as set out in Schedule 4 of the Waste Management Licensing Regulations 1994. (For the equivalent Regulations in Scotland and Northern Ireland, see Appendix 2.)

The relevant objectives, contained in paragraph 4, Schedule 4 of the Waste Management Licensing Regulations 1994 *(SI 1994/1056 as amended)* are extensive, but will only require attention for activities that involve the recovery or disposal of waste. Paragraph 4 (1) is as follows:

a) *"ensuring the waste is recovered or disposed of without endangering human health and without using process or methods which could harm the environment and in particular without:*

- *risk to water, air, soil, plants or animals; or*
- *causing nuisance through noise or odours; or*
- *adversely affecting the countryside or places of special interest;*

b) *implementing, as far as material, any plan made under the plan-making provisions".*

The application of BAT is likely to already address risks to water, air, soil, plants or animals, odour nuisance and some aspects of effects on the countryside. It will, however, be necessary for the Operator briefly to consider each of these objectives individually and provide a comment on how they are being addressed by your proposals. It is also necessary to ensure that any places of special concern that could be affected, such as SSSIs, are identified and commented upon although, again, these may have been addressed in your assessment for BAT, in which case a cross-reference may suffice.

Operators should identify any development plans made by the local planning authority, including any waste local plan, and comment on the extent to which the proposals accord with the contents of any such plan (see Section 2.6).

4.3 The Habitats Regulations

Application form
Question 4.3

Provide an assessment of whether the installation is likely to have a significant effect on a European site in the UK and, if it is, provide an assessment of the implications of the installation for that site, for the purposes of the Conservation (Natural Habitats etc) Regulations 1994 (SI 1994/2716).

Your response should cover all relevant issues pertinent to your installation, including those below. In doing so, you should justify your proposals against any indicative requirements stated.

An application for an IPPC Permit will be regarded as a new plan or project for the purposes of the Habitats Regulations (for the equivalent Regulations in Scotland and Northern Ireland see Appendix 2). Therefore, Operators should provide an initial assessment of whether the installation is likely to have a significant effect on any European site in the UK (either alone or in combination with other relevant plans or projects) and, if so, an initial assessment of the implications of the installation for any such site. The application of BAT is likely to have gone some way towards addressing the potential impact of the installation on European sites and putting into place techniques to avoid any significant effects. The Operator should provide a description of how the BAT assessment has specifically taken these matters into account, bearing in mind the conservation objectives of any such site.

European sites are defined in Regulation 10 of the Habitats Regulations to include Special Areas of Conservation (SACs); sites of community importance (sites that have been selected as candidate SACs by member states and adopted by the European Commission, but which are not yet formally classified); and Special Protection Areas (SPAs). It is also Government policy (set out in PPG 9 on nature conservation) that potential SPAs and candidate SACs should be considered to be European sites for the purposes of Regulation 10.

Information on the location of European sites and their conservation objectives is available from:

- English Nature (01733 455000), http://www.english-nature.org.uk
- Countryside Council for Wales (01248 385620), http://www.ccw.gov.uk
- Scottish Natural Heritage (0131 447 4784), http://www.snh.org.uk
- Joint Nature Conservation Committee (01733 866852), http://www.jncc.gov.uk
- Environment and Heritage Service, Northern Ireland, http://www.ehsni.gov.uk

The Regulator will need to consider the Operator's initial assessment. If it concludes that the installation is likely to have a significant effect on a European site, then the Regulator will need to carry out an “appropriate assessment” of the implications of the installation in view of that site's conservation objectives. The Regulations impose a duty on the Regulator to carry out these assessments, so it cannot rely on the Operator's initial assessments. Therefore the Regulator must be provided with any relevant information upon which the Operator’s assessment is based.

Note that in many cases the impact of the Habitats Regulations will have been considered at the planning application stage, in which case the Regulator should be advised of the details.

REFERENCES

For a full list of available *Technical Guidance* see Appendix A of the *A1 Guide for Applicants* or visit the Environment Agency website http://www.environment-agency.gov.uk. Many of the references below are being made available free of charge for viewing or download on the Website. The same information can also be accessed via the SEPA website http://www.sepa.org.uk, or the NIEHS website http://www.ehsni.gov.uk**.** Most titles will also be available in hard copy from The Stationery Office (TSO). Some existing titles are not yet available on the website, but can be obtained from TSO.

1. IPPC Reference Document on *Best Available Techniques in the Glass Manufacturing Industry* European Commission http://eippcb.jrc.es
2. *The Pollution Prevention and Control Act 1999* (http://www.legislation.hmso.gov.uk).
3. *The Pollution Prevention and Control Regulations* SI 1973 2000 (http://www.legislation.hmso.gov.uk).
4. *IPPC: A Practical Guide (for England and Wales)* or equivalents in Scotland and Northern Ireland (http://www.defra.gov.uk/environment/ppc/ippc.htm).
5. *IPPC Part A(1) Installations: Guide for Applicants,* includes Preparation of a Site Report in a Permit Application (EA website, as above), or equivalent guidance in Scotland or Northern Ireland.
6. Assessment methodologies:
   - *IPC E1 BPEO Assessment Methodology for IPC,* The Stationery Office, ISBN 0 10 542499.
   - *IPPC Environmental Assessments for BAT*, (in preparation as H1)
7. Management system references:
   - Sector-specific
8. Waste minimisation support references:
   - Environment Agency website. Waste minimisation information accessible via: www.environment-agency.gov.uk/business
   - *Waste Minimisation – an environmental good practice guide for industry* (help to minimise waste and achieve national environmental goals). Available free to companies that intend to undertake a waste-reduction programme (tel 0345 337700).
   - *Profiting from Pollution Prevention – 3Es methodology* (emissions, efficiency, economics). Video and A4 guide aimed at process industries. Available from Environment Agency, North East Region (tel 0113 244 0191, ask for regional PIR).
   - *Waste Minimisation Interactive Tools (WIMIT)*. Produced in association with the Envirowise and the BOC Foundation (a software tool designed for small and medium businesses). Available free from The Environmental Helpline (tel 0800 585794).
   - *Envirowise*. A joint DTI/DETR programme, with over 300 free case studies, good practice guides, leaflets, flyers, software tools and videos covering 12 industry sectors, packaging, solvents and the generic areas of waste minimisation and cleaner technology.
   - *Envirowise* is accessible via a free and confidential helpline (tel 0800 585794) which gives up to 2 hours free advice over the phone and free short site visits for companies with <250 staff. Envirowise is also accessible via its web site www.envirowise.gov.uk
   - *Envirowise, Increased Profit Through Improved Materials Additions: Management/Technical Guide*, GG194/195. - don't quite understand why this has been picked out - need more info on the context of this
   - *Institution of Chemical Engineers Training Package E07 – Waste Minimisation*. Basic course which contains guide, video, slides, OHPs and the like (tel 01788 578214)
9. Water efficiency references:
   - *Envirowise, Simple measures restrict water costs*, GC22.
   - *Envirowise, Effluent costs eliminated by water treatment*, GC24.
   - *Envirowise, Saving money through waste minimisation: Reducing water use*, GG26.
   - *Envirowise* Helpline (0800 585794).
10. Environment Agency (1998) *Optimum use of water for industry and agriculture dependent on direct abstraction: Best practice manual.* R&D technical report W157, WRc Dissemination Centre, Swindon (tel 01793 865012).
11. Releases to air references:
    - *BREF on Waste Water and Waste Gas Treatment*.
    - *A1 Guidance on effective flaring in the gas, petroleum etc industries*, 1993, ISBN 0-11-752916-8.
    - *A2 Pollution abatement technology for the reduction of solvent vapour emissions*, 1994, £5.00, ISBN 0-11-752925-7.
    - *A3 Pollution abatement technology for particulate and trace gas removal*, 1994, £5.00, ISBN 0-11-752983-4.
    - *Landfill gas flaring*
    - *Part B PG1/3 Boilers and Furnaces 20-50 MW net thermal input* (ISBN 0-11-753146-4-7).
    - *Part B PG1/4 Gas Turbines 20-50 MW net thermal input* (ISBN 0-11-753147-2).
12. Releases to water references:
    - *BREF on Waste Water and Waste Gas Treatment.*
    - *A4 Effluent Treatment Techniques*, TGN A4, Environment Agency, ISBN 0-11-310127-9.

- Environment Agency, *Pollution Prevention Guidance Note – Above-ground oil storage tanks*, PPG 2, gives information on tanks and bunding which have general relevance beyond just oil (EA website, as above).
- Mason, P. A, Amies, H. J, Sangarapillai, G. Rose, *Construction of bunds for oil storage tanks*, Construction Industry Research and Information Association (CIRIA), Report 163, 1997, CIRIA, 6 Storey's Gate, Westminster, London SW1P 3AU. Abbreviated versions are also available for masonry and concrete bunds (www.ciria.org.uk online purchase).

13. *Dispersion Methodology Guide D1* (EA website, as above - summary only).
14. *IPPC Energy Efficiency Guidance Note* (the consultation version, available on the EA website, as above, should be used until the final version is published).
15. BS 5908: *Code of Practice for Fire Precautions in the Chemical and Allied Industries.*
16. 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, as above).
17. *Investigation of the criteria for, and guidance on, the landspreading of industrial wastes* – final report to the DETR, the Environment Agency and MAFF, May 1998.
18. Agency guidance on the exemption 7 activity (proposed).
19. COMAH guides
    - *A Guide to the Control of Major Accident Hazards Regulations 1999*, Health and Safety Executive (HSE) Books L111, 1999, ISBN 0 07176 1604 5.
    - *Preparing Safety Reports: Control of Major Accident Hazards Regulations 1999*, HSE Books HS(G)190, 1999.
    - Emergency Planning for Major Accidents: Control of Major Accident Hazards Regulations 1999, HSE Books HS(G)191, 1999.
    - *Guidance on the Environmental Risk Assessment Aspects of COMAH Safety Reports, Environment Agency, 1999* (EA website, as above).
    - *Guidance on the Interpretation of Major Accidents to the Environment for the Purposes of the COMAH Regulations*, DETR, 1999, ISBN 753501 X, available from the Stationery Office.
20. *Assessment and Control of Environmental Noise and Vibration from Industrial Activities* (joint Regulator's guidance in preparation)
21. Monitoring Guidance (EA website, as above):
    - M1 *Sampling facility requirements for the monitoring of particulates in gaseous releases to atmosphere*, March 1993, £5.00, ISBN 0-11-752777-7.
    - M2 *Monitoring emissions of pollutants at source,* January 1994, £10.00, ISBN 0-11-752922-2.
    - M3 *Standards for IPC Monitoring Part 1: Standards, organisations and the measurement infrastructure*, August 1995, £11.00, ISBN 0-11-753133-2.
    - M4 *Standards for IPC Monitoring Part 2 : Standards in support of IPC Monitoring*, revised 1998
    - MCERTS approved equipment link via http://www.environment-agency.gov.uk/business *Guidance for Business and Industry*.
    - *Direct Toxicity Assessment for Effluent Control: Technical Guidance* (2000), UKWIR 00/TX/02/07.
    - H5: *Use of Direct Toxicity Assessment in IPPC (draft, in preparation).*
22. *The Categorisation of Volatile Organic Compounds*, DOE Research Report No DOE/HMIP/RR/95/009 (EA website, as above).
23. *Odour Assessment and Control – Guidance for Regulators and Industry* (joint agencies' guidance in preparation).
24. *Policy and Practice for the Protection of Groundwater,* PPPG (EA website, as above).
25. *Working at Construction and Demolition-sites,* PPG 6 (EA website, as above).

ABBREVIATIONS

BAT	Best Available Techniques – see *IPPC A Practical Guide* or the Regulations for further definition
BAT Criteria	The criteria to be taken into account when assessing BAT, given in Schedule 2 of the PPC Regulations
BOD	Biological Oxygen Demand
BREF	BAT Reference Document
CCA	Climate Change Agreement
CEM	Continuous Emissions Monitoring
CHP	Combined heat and power plant
COD	Chemical Oxygen Demand
COMAH	Control of Major Accidental Hazards Regulations
DETR	Department of the Environment, Transport and the Regions
DTI	Department of Trade and Industry
EALs	Environmental Action Levels
EMAS	EC Eco Management and Audit Scheme
EMS	Environmental Management System
EQS	Environmental Quality Standards
ETBPP	Environmental technology best practice programme
GBRs	General binding rules
IEMA	Institute of Environmental Management and Assessment
ITEQ	International Toxicity Equivalents
LDAR	Leak detection and repair
MCERTS	Monitoring Certification Scheme
NIEHS	Northern Ireland Environment and Heritage Service
PPPG	Policy and Practice for the Protection of Groundwater
SAC	Special Areas of Conservation
SECp	Specific Energy consumption
SEPA	Scottish Environmental Protection Agency
SPA	Special Protection Area
SSSI	Sites of Special Scientific Interest
TSS	Suspended solids
TOC	Total Organic Carbon
VOC	Volatile organic compounds

APPENDIX 1 - SOME COMMON MONITORING AND SAMPLING METHODS

Table A1.1: Measurement methods for common substances to water

Determinand	Method	Detection limit Uncertainty	Valid for range mg/l	Standard
Suspended solids	Filtration through glass fibre filters	1 mg/l 20%	10-40	ISO 11929:1997, EN872 - Determination of suspended solids
COD	Oxidation with di-chromate	12 mg/l 20%	50-400	ISO 6060: 1989, Water Quality - Determination of chemical oxygen demand
BOD_5	Seeding with micro-organisms and measurement of oxygen content	2 mg/l 20%	5-30	ISO 5815: 1989, Water Quality Determination of BOD after 5 days, dilution and seeding method **EN 1899 (BOD 2 Parts)**
AOX	Adsorption on activated carbon and combustion	-- 20%	0.4 - 1.0	ISO 9562: 1998, EN1485 - Determination of adsorbable organically bound halogens.
Tot P				BS 6068: Section 2.28 1997, Determination of phosphorus –ammonium molybdate spectrometric method
Tot N				BS 6068: Section 2.62 1998, Determination of nitrogen Part 1 Method using oxidative digestion with peroxydisulphate, BS EN ISO 11905
pH				SCA The measurement of electric conductivity and the determination of pH, ISBN 0117514284
Turbidity				SCA Colour and turbidity of waters 1981, ISBN 0117519553 **EN 27027:1999**
Flow rate	Mechanical ultrasonic or electromagnetic gauges			SCA Estimation of Flow and Load, ISBN 011752364X
Temperature				
TOC				SCA The Instrumental Determination of Total Organic Carbon and Related Determinants 1995, ISNB 0117529796 **EN 1484:1997**
Fatty acids				Determination of Volatile Fatty Acids in Sewage Sludge 1979, ISBN 0117514624
Metals				BS 6068: Section 2.60 1998, Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy
Chlorine				BS6068: Section 2.27 1990, Method for the determination of total chlorine: iodometric titration method
Chloroform Bromoform				BS 6068: Section 2.58, Determination of highly volatile halogenetaed hydrocarbons – Gas chromatographic methods
Dispersants Surfactants Anionic Cationic Non-ionic				SCA Analysis of Surfactants in Waters, Wastewaters and Sludges, ISBN 01176058 **EN 903:1993 (Used for anionic surfactants)**
Pentachloro-Phenol				BS5666 Part 6 1983, Wood preservative and treated timber quantitative analysis of wood preservatives containing pentachlorophenol **EN 12673:1997 (used for chlorophenol and polychlorinated phenols)**
Formaldehyde				SCA The determination of formaldehyde, other volatile aldehydes and alcohols in water
Phosphates and nitrates				BS 6068: Section 2.53 1997, Determination of dissolved ions by liquid chromatography
Sulphites and sulphates				BS 6068: Section 2.53 1997, Determination of dissolved ions by liquid chromatography
Ammonia				BS 6068: Section 2.11 1987, Method for the determination of ammonium: automated spectrometric method
Grease and oils	IR absorption	0.06 mg/kg		SCA The determination of hydrocarbon oils in waters by solvent extraction IR absorption and gravimetry, ISBN 011751 7283

APPENDIX 1 - MONITORING AND SAMPLING METHODS

Table A1.2: Measurement methods for air emissions

Determinand	Method	Averaging time Detection limit Uncertainty	Compliance criterion	Standard
Formaldehyde	Impingement in 2,4 dinitro-phenyl-Hydrazine HPLC	1 hour 1 mg/m^3 30%	Two samples taken. Each result below limit after subtraction of measurement uncertainty	NIOSH
Ammonia	Ion Chromato-graphy	1 hour 0.5mg/m^3 25%		US EPA Method 26
VOCs speciated	Adsorption Thermal Desorption GCMS	1 hour 0.1 mg/m^3 30%		BS EN 1076: Workplace atmospheres. Pumped sorbent tubes for the determination of gases and vapours. Requirements and test methods.
Chloroform	Absorption on activated carbon solvent extraction. GC analysis	1 hour 1 mg/m^3 20%		MDHS 28 Chlorinated hydrocarbon solvent vapours in air (modified)
Oxides of sulphur	UV fluoresence automatic analyser	1 hour 1 ppm 10%	95% of hourly averages over a year below specified limit	ISO 7935 (BS6069 Section 4.4) Stationary source emissions - determination of mass concentrations of sulphur dioxide CEN Standard in preparation
	Wet sampling train Ion chromatography	1 hour 1 mg/m^3 25%	Two samples taken. Each result below limit after subtraction of measurement uncertainty	ISO 7934 (BS6069 Section 4.1) Method for the determination of the mass concentration of sulphur dioxide-hydrogen peroxide/barium perchlorate method

Measurement uncertainty is defined as total expanded uncertainty at 95% confidence limit calculated in accordance with the *Guide to the Expression of Uncertainty in Measurement*, ISBN 92-67-10188-9, 1st Ed., Geneva, Switzerland, ISO 1993.

See also Monitoring Guidance (Reference 21).

APPENDIX 2 - EQUIVALENT LEGISLATION IN SCOTLAND & NORTHERN IRELAND

The legislation referred to in the text is that for England and Wales. The following are the equivalents for Scotland and Northern Ireland.

Table A2.1: Equivalent legislation

England and Wales	*Scotland*	*Northern Ireland*
PPC Regulations (England and Wales) 2000	PPC (Scotland) Regulations 2000, SI 200/323	To be prepared
SI:1994 1056: Waste Management Licensing Regulations	SI:1994 1056: Waste Management Licensing Regulations	No NI equivalent
The Water Resources Act 1991	COPA 1974 (S30A-30E equiv to Part III WRA91): Natural Heritage (Scotland) Act 1991 (Part II equiv to Part I WRA91)	The Water (NI) Order 1999
SI 1989 No 317: Clean Air, The Air Quality Standards Regulations 1989	SI 1989/317: Clean Air, The Air Quality Standards Regulations 1989	The Air Quality Standards Regulations (Northern Ireland) 1990. Statutory Rules of Northern Ireland 1990 No 145
SI 1997 No 3043: Environmental Protection, The Air Quality Regulations 1997	SSI 2000/97: The Air Quality (Scotland) Regulations	No NI equivalent
SI 1989 No 2286 and 1998 No 389: The Surface Water (Dangerous Substances Classification) Regulations. (Values for List II substances are contained in SI 1997/2560 and SI 1998/389)	SI 1990/126: Surface Water (Dangerous Substances) (Classification) (Scotland) Regulations	Surface Waters (Dangerous Substances) (Classification) Regulations 1998. Statutory Rules of Northern Ireland 1998 No 397 SI1991/1597
SI 1991/1597: Bathing Waters (Classification) Regulations	SI 1991/1609: Bathing Waters (Classification) (Scotland) Regulations	The Quality of Bathing Water Regulations (NI) 1993
SI 1992/1331 and Direction 1997: Surface Waters (Fishlife) (Classification) Regulations	SI 1997/2471: Surface Waters (Fishlife) (Classification) Regulations	The Surface Water (Fishlife) (Classification) Regulations (NI) 1997
SI1997/1332: Surface Waters (Shellfish) (Classification) Regulations	SI 1997/2470: Surface Waters (Shellfish) (Classification) Regulations	The Surface Water (Shellfish) (Classification) Regulations (NI) 1997
SI1994/2716: Conservation (Natural Habitats etc) Regulations 1994	SI 1994/2716: Conservation (Natural Habitats etc) Regulations	Conservation (Natural Habitats etc) Regulations (Northern Ireland) 1995
Control of Major Accident Hazards Regulations 1999 (COMAH)	SI 1999/743: Control of Major Accident Hazards Regulations	Control of Major Accident Hazard Regulations (Northern Ireland) 2000
SI 1998/2746: The Groundwater Regulations	SI 1998/2746: The Groundwater Regulations	Statutory Rule 1998 No. 401. The Groundwater Regulations (NI)