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Process Guidance

Non-Ferrous Metals: Supplementary Guidance



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Processes Subject to Integrated Pollution Control

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1 Introduction

1.1 Scope and status of Guidance Note

This IPC Guidance Note is issued by the Environment Agency as one of a series of guidance notes for processes prescribed for Integrated Pollution Control (IPC) in Regulations⁽¹⁾ made under Section 2 of the Environmental Protection Act 1990 (EPA90). It deals with techniques and standards relevant to the processes covered by the Note.

This document provides supplementary information to be used in conjunction with Her Majesty's Inspectorate of Pollution Chief Inspector's Guidance Notes (CIGN) IPR2/4 to IPR 2/12⁽²⁾ and other relevant guidance⁽³⁾ in assessing operators' proposals relating to their authorisations under EPA90. It should be used together with separate guidance on monitoring⁽⁴⁾, dispersion methodology⁽⁵⁾⁽⁶⁾ and assessment principles for determining best available techniques not entailing excessive cost (BATNEEC) and the best practicable environmental option (BPEO)⁽⁷⁾ to provide a framework for a consistent approach to the regulation of this class of IPC process.

The Environment Act 1995⁽⁸⁾ by which the Environment Agency was created, placed general duties upon the Environment Agency with regard to conservation, waste minimisation and sustainable development.

These general duties do not alter the specific requirements of EPA 90 that BATNEEC and BPEO be used, but they may influence the decision as to which techniques meet the criterion of "Best" in any particular circumstances.

This Note represents the state of understanding at the time of writing, and includes:

- a description of those aspects of the processes where developments have occurred in techniques which may affect decisions concerning BATNEEC or BPEO;
- guidance on best available techniques for the control of releases, where different from those presented in (CIGN) IPR2/4 to IPR2/12;
- benchmark achievable release levels;
- other environmental standards relevant to the process;
- information on the economic implications of the relevant pollution control techniques.

An operator should keep up to date with the best available techniques relevant to the process. This Note may not therefore be cited in an attempt to delay the introduction of improved, available techniques, and, except where specifically stated to the contrary, nothing contained herein should be considered prescriptive.

The concepts of BATNEEC and BPEO expressed in EPA90 and associated Regulations are site-specific. This Note cannot take into account such site-specific considerations. Thus, while operators' proposals should be judged against the benchmark release levels given in this Note and in the relevant CIGN (referred to there as achievable release concentrations), the benchmarks should not be applied as uniform release limits. They are indicative, but not prescriptive, for new processes that are expected to use modern techniques for the prevention, minimisation and abatement of releases.

Where other release levels are proposed for a specific case, comparing them with the benchmark release levels will indicate the degree of technical and economic justification required to be provided by the operator. Conditions in authorisations that relate to permitted releases should ensure that all factors, including those which are site-specific, have been taken into account, and that the legal requirements to use BATNEEC and BPEO are fully satisfied.

Compliance with statutory environmental quality standards or objectives, and with agreed international obligations relating to permitted releases or environmental standards, is mandatory. No discretion is permitted without formal policy approval.

1.2 Existing processes

Most existing processes should have completed their improvement programmes and, subject to the above points, should either be achieving the relevant benchmark release levels given in Section 4 or closely approaching them. Where this is not so, a timetable for further improving or decommissioning the process should be required.

1.3 Processes covered by this Note

The processes covered by this Note are those defined in Section 2.2 Non Ferrous Metals, Part A of the Environmental Protection (Prescribed Processes and Substances) Regulations 1999, as amended.

These processes are described in CIGN's IPR 2/4 to 2/12.

Where other prescribed processes are carried on in conjunction with the primary process, reference should be made to the relevant CIGNs or IPC Guidance Notes (IPCGNs) and, where appropriate, the Secretary of State's Guidance for Local Authority Air Pollution Control on the ancillary processes insofar as they have potential for releases to the environment.

In the context of this Note "process" is from receipt of raw materials via production of intermediates to dispatch of finished products, byproducts and wastes.

1.4 Reference conditions used in this Note

Unless otherwise specified, reference conditions of substances in releases to air from point sources are: temperature 273 K (0°C), pressure 101.3 kPa (1 atmosphere), no correction for water vapour or oxygen.

These reference conditions relate to the benchmark release levels given in this Note and in CIGNs IPR 2/4 to IPR 2/12.

Care should always be taken to convert benchmark and proposed releases to the same reference conditions for comparison. The Authorisation may employ different reference conditions if they are more suitable for the process in question.

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

Releases may be expressed in terms of mg/m³, g/h or g/t (product) as appropriate.

1.5 Additional information on standards and obligations

1.5.1 Air quality standards

Statutory Instrument 1989 No 317, Clean Air, The Air Quality Standards Regulations 1989⁽¹⁰⁾, gives limit values in air for the following substances:

- sulphur dioxide
- suspended particulates
- lead
- nitrogen dioxide

Any emission from the process should not result in a breach of the appropriate air quality standard beyond the site boundary.

1.5.2 Air quality objectives

Statutory Instrument 1997 No 3043, Environmental Protection, The Air Quality Regulations 1997⁽¹¹⁾, gives air quality objectives to be achieved by 2005 for:

- benzene
- 1,3-butadiene
- carbon monoxide
- lead
- nitrogen dioxide
- PM₁₀
- sulphur dioxide

1.5.3 The UNECE convention on long-range transboundary air pollution

A requirement has been agreed under this convention⁽¹²⁾, to further reduce SO₂ emissions from all sources. The second Sulphur Protocol (Oslo, 1994) obliges the UK to reduce SO₂ emissions by 80% (based on 1980 levels) by 2010. Negotiations are now under way which could lead to a requirement to further reduce emissions of NO_x and volatile organic compounds (VOCs).

1.5.4 Volatile organic compounds

Reducing Emissions of VOCs and Levels of Ground Level Ozone: A UK Strategy⁽¹³⁾ was published by the Department of the Environment in October 1993. It sets out how the Government expects to meet its obligations under the current UNECE VOCs Protocol to reduce its emissions by 30% (based on 1988 levels) by 1999, including the reductions projected for the major industrial sectors.

The Montreal Protocol⁽¹⁴⁾ concerns substances that deplete the ozone layer. These include chlorinated fluorocarbons, halons, carbon tetrachloride, 1,1,1-trichloroethane and methyl bromide.

EC Directive 90/415/EEC⁽¹⁴⁾ covers releases to water from the production and use of 1,2-dichloroethane, trichloroethylene, perchloroethylene and trichlorobenzene.

An EC Directive on the limitation of emissions of VOCs due to the use of organic solvents in certain activities and installations (the "Solvents Directive") is likely to be adopted soon.

1.5.5 Water quality standards

Statutory Instrument (1989) No 2286 and (1998) No 389⁽¹⁵⁾, The Surface Waters (Dangerous Substances Classification) Regulations, gives annual mean concentration limit values for certain substances in receiving waters.

1.5.6 Groundwater protection

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 Agency's document Policy and Practice for the Protection of Groundwater (PPPG)⁽¹⁶⁾. This outlines the concepts of vulnerability and risk and the likely acceptability from the Agency's viewpoint of certain activities within groundwater protection zones.

The EC Directive on the Protection of Groundwater Against Pollution Caused by Certain Dangerous Substances (80/68/EEC)⁽¹⁷⁾ imposes an obligation on Member States to prevent the introduction into groundwater of List I substances and to limit the introduction of List II substances so as to prevent pollution of groundwater. List I and List II substances are described in Appendix 1 of the PPPG. The Directive is at present implemented by, among other things:

- Part I of the Environmental Protection Act 1990, which requires authorisation of IPC processes;

- Part II of that Act, which requires the management of controlled wastes;
- Regulation 15 of the Waste Management Licensing Regulations 1994, which requires the Agency to observe the provisions of the Groundwater Directive when issuing waste management licences;
- Part II of the Water Resources Act 1991, which make it an offence to discharge polluting matter to controlled waters, except in accordance with a consent issued by the Agency.

The Government has introduced the Groundwater Regulations 1998 to provide additional protection and complete the transposition of the Groundwater Directive. In addition to those processes controlled for IPC, these Regulations relate to activities where List I and II substances are either deliberately discharged, or where there is a risk of discharge occurring, for example as a result of spillages or leaks. The Regulations provide for prior investigation of the potential effects of discharges on groundwater; the Authorisation of disposal or tipping to land and Consents to discharge to groundwater; the serving of Notices by the Agency to prohibit activities or to apply conditions; the recognition the importance of Codes of Practice; and provisions for cost recovery by the Agency.

Two key aspects of the Groundwater Directive are the need for:

- 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 Agency 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.

- Requisite 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.

The Directive states 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 Agency where this is being considered as a justification for such discharges.

The Agency is obliged to take account of these requirements for IPC processes and, where there is an activity that represents a potential risk to groundwater, may request further investigations.

2 Processes, potential release routes and specialised techniques for controlling releases

2.1 Introduction

The processes covered by this Note fall into three basic groups: extraction of metals from their ores, recovery of metals from scrap, and the manufacture of alloys. In a small number of instances a foundry process is associated with the primary process.

In all cases the industry can be considered mature, with no significant developments in extraction and manufacturing technology since the publication of CIGN's IPR 2/4 to IPR 2/12.

There have, however, been developments in processing techniques and waste minimisation relevant to the requirement to use BPEO and BATNEEC. These are described below.

The process for making phosphor copper is also described. This is not a prescribed process in itself, but becomes part of the prescribed process when the associated melting furnace conforms to one of the definitions in the Prescribed Processes and Substances Regulations as amended.

Also included are descriptions of an electrically heated shaft furnace, and processes for manufacturing aluminium master alloys.

2.2 Activities common to several classes of process

2.2.1 Foundry work using sand moulds and cores

Table 2.1, which is reproduced from Appendix 3 of *Cost-Effective Management of Chemical Binders in Foundries*⁽¹⁾, illustrates the wide range of systems available for cold setting processes. There is also a range of heat cured processes available, together with green sand systems.

When assessing an application for an authorisation for a non-ferrous metals foundry, the Agency should expect the following aspects to have been addressed:

- effective containment of sand, particularly during receipt and conveying;
- safe systems for receipt and handling of liquid raw materials;
- safe systems for handling and using gases;
- recycling used moulds and cores;
- effective extraction systems to prevent air pollution arising from mould preparation, curing and the casting operation.

In addition to the basic principles involved, effective environmental protection and, in particular, waste minimisation, depend to a great extent upon detailed design and control of the process by the operator.

Further information on these processes and other aspects of sand use can be found in Guidance Note GG119⁽¹⁾ *Optimising Sand Use in Foundries* and Guidance Note GG 104 *Cost-Effective Management of Chemical Binders in Foundries*.

Table 2.2 summarises releases and potential release routes for mould and core making processes.

Table 2.1 Cold setting processes

SYSTEM	CURING AGENT, SELF TEST	CURING AGENT, GAS
Alkaline phenolic	Esters	Methyl formate or carbon dioxide
Furan	Acids	Sulphur dioxide
Phenolic urethane	Amines	Amines
Silicate	Esters	Carbon dioxide

Table 2.2 Mould and core making processes

POTENTIAL RELEASE ROUTES FOR PRESCRIBED SUBSTANCES AND OTHER SUBSTANCES WHICH MAY CAUSE HARM

Source of releases				Alkali metal compounds	Sand and silica dust	Amines and amides	Volatile organic compounds	Resins
To	Air	Water	Land					
Prescribed	A	W	L					
Other	a	w	l					
Storage and handling of sand, including reclaim					A l			
Storage and handling of resins, binders and hardeners				L w		A w	A w	lw

NOTES

Substances include their compounds except where separate reference to the compound is made.

Releases to air may be released to land or water, depending upon the abatement technology employed.

Some releases are specific to a particular binder system.

2.2.2 Swarf de-oiling

As described in CIGN IPR2/8, swarf dryers are widely used to remove cutting oils from aluminium swarf. They are also used for other metals.

It remains the view that indirectly heated dryers are the best available technique (BAT) for the removal of oil from swarf.

Pre-treatment of the swarf using a centrifuge to remove a portion of the oil provides benefits in that:

- it may be possible to use the recovered oil either as a lubricant or as a fuel;
- control of the dryer will be improved by reducing the risk of overloading the after burners.

It is therefore considered to be BAT to pre-treat swarf using a centrifuge prior to drying.

2.3 Production of zinc, lead and cadmium from bulk sulphide concentrates

The only process operated in the UK to extract zinc or lead from any ore is the ISF blast furnace process. This process, in which the sulphide concentrate is first converted to mixed oxides on a sinter strand, is described in IPR 2/4, IPR 2/5 and IPR 2/7. In principle, it remains unchanged since the publication of these Notes.

However, two significant process changes have been made at the primary plant, namely:

- direct casting of lead bullion into moulds, thereby eliminating the need for removal and processing copper drosses at the smelter;

- altering the raceways of hot blast tuyeres so as to allow drosses and other powdery materials to be injected with the air blast.

The first of these changes simply transfers removal of copper to the lead refinery.

Injecting fine materials into the blast furnace through the tuyeres has the benefit of avoiding briquetting, and also reduces the recirculating load on the sinter strand. Tuyere injection technology may allow zinc to be recovered from low grade materials such as filter dust from steel making. The zinc concentration in these dusts is too low for economic recovery by briquetting and subsequent reduction.

2.4 Refining lead

There has been a significant change in primary lead refining as a consequence of the changes in smelter practice described in 2.3 affecting primary lead arising in the UK. Some overseas sources have made similar changes. These changes necessitate the addition of a copper dross removal stage at the lead refineries. Otherwise the process is as described in CIGN IPR 2/5.

Concerning techniques for controlling releases described in CIGN IPR 2/5:

- kettles should be fitted with temperature control devices to avoid overheating the lead;
- dross receptacles should be fitted with extraction systems which are effective during dross removal and subsequent cooling.

2.5 Alloying and casting of lead and zinc

There have been no major developments which impact upon the guidance given in CIGNs IPR 2/4 and 2/5.

2.6 Primary aluminium production

2.6.1 Secondary collection of fume from electrolysis cells

DOE Report Number DOE/HMIP/RR/93/029⁽⁹⁾ notes that at one smelter in the UK, pot room fumes which evade the primary collection system are collected in roof ridge ducts and discharged by fans through 80 metre tall stacks.

At the other major site, fumes which escape from the primary extraction system are relayed into the atmosphere at about 20 metres through ventilation slots in the roof ridge.

If a collection efficiency of 98% is assumed for the primary hood system and a removal efficiency of 98% for fluorides present in the collected gases, the quantity of fluoride discharged through the secondary systems is approximately equal to that discharged through the primary system. Recent advice suggests that the proportion which escapes untreated may be even higher. The effectiveness with which this secondary discharge is dispersed is therefore a significant factor in deciding the environmental impact of the smelter upon its immediate surroundings.

Since an effective roof collection system feeding gases to stacks which provide adequate dispersion is already in use, it must be considered to be BAT.

2.6.2 Discharge of solid wastes - spent anodes

Primary aluminium smelters are normally supplied with carbon anodes by dedicated anode manufacturing plants operating under common management on an immediately adjacent site.

The anodes are consumed by oxygen generated during electrolysis, and butts must be removed on a regular basis before they become excessively prone to failure.

The anode butts which are removed from the cells are cleaned to remove electrolyte before being crushed and recycled. The metal hanger bars are also recycled.

Control of this waste recycling operation is a crucial factor in minimising fluoride releases from the overall smelter complex.

The potential environmental impacts are:

- high fluoride concentrations in recovered butts will permeate into bake furnace flues and may be discharged into the atmosphere;
- high fluoride concentrations will lead to rapid deterioration of bake furnace flues, causing poor efficiency and enhanced releases;

- high alkali metal concentrations in the recovered butts will lead to friability in anodes, causing more frequent anode changes in the cell room, and increasing the risk of anode failure.

Therefore there is a need to ensure that quality control procedures for anode butt cleaning are incorporated into the authorisation of either the aluminium smelter or its associated anode plant. Whichever is considered more appropriate will depend upon the management arrangements of the site concerned.

Anode butts must, however, be recognised as a waste stream arising from the smelting operation.

2.7 Secondary aluminium processes

2.7.1 Introduction

There have been no significant advances in the technology of secondary aluminium manufacture since the issue of CIGN IPR 2/8. Developments in pollution prevention are therefore based upon application of existing technology.

2.7.2 Furnace selection

As described in IPR 2/8 there is a range of furnace types which can be used to handle metal from a variety of sources.

While a particular combination of pretreatment and furnace may be considered BAT for a specified raw material, it may be wholly unsuitable for other raw materials.

The applicant for authorisation of a furnace in which aluminium is treated should provide details as to:

- the nature of the flux to be used, and the environmental significance of its constituents;
- the means whereby drosses or slags are to be removed from the furnace;
- the design of the fume containment system which will operate during drossing or slag pouring;
- the dross handling system, including a system for preventing releases of dust and fume into the atmosphere during cooling;
- provision for ensuring that materials do not become wet accidentally;
- provision for ensuring that dross fines are treated to minimise reactivity with water prior to final disposal;
- the range of alloys to be made.

The applicant should specify the range of raw materials for which the system is suitable, and the authorisation should exclude any raw materials not so specified.

2.7.3 Demagging

IPR 2/8 describes BAT for demagging as "... injection of chlorine mixed with nitrogen or argon into the refining/holding furnace or into a proprietary degassing unit".

The Guidance then goes on to indicate an achievable release concentration for chlorine in the exhaust from demagging operations as being 5 mg/m³. Since the use of a proprietary unit will generate much less exhaust than a furnace, the use of a dedicated demagging unit shall in future be regarded as BAT.

2.7.4 Manufacture of alloys

The applicant should identify the range of alloys which are to be manufactured, in particular those which require the furnace to be heated to a temperature significantly in excess of that normally required to melt aluminium. When assessing the application, the Agency should ensure that the fume extraction and filtration systems have been designed to cope with the additional volume of exhaust gases generated at elevated temperatures.

Problems associated with slow dissolution rates for alloying constituents can be minimised by using master alloys.

2.7.5 Master alloys

Master alloys of aluminium with silicon, manganese, iron or copper are frequently used when making aluminium alloys. In order to dissolve the alloying constituent in the molten aluminium, it is necessary to superheat the melt to a significant extent, while the time taken to achieve homogeneity can be reduced by increased agitation. Both factors contribute to significantly greater rates of fume generation.

The extraction and filtration systems for gases from furnaces used to make master alloys must be designed with these elevated temperatures and high fume loading in mind.

2.7.6 Treatment of slags and drosses

The amount and nature of dross or slag generated during melting varies greatly with the nature of the raw material, the type of furnace and the quantity of flux used. An electric induction furnace being used to melt clean metal will require a few kilograms of cover flux per tonne of melt, whereas a rotary furnace charged with metal recovered from dross may need up to 500 kg of flux per tonne of metal.

Fluxes serve several purposes – they form a barrier to oxidation of the metal, assist agglomeration of non-metallic materials to form a slag, and in rotary furnaces improve the transfer of heat from the exposed walls to the metal. Fluxes may also contain reactive components which will alter the proportion of alloy constituents such as magnesium in the melt.

Material which has been removed in a dry or sticky condition by raking across the metal surface is referred to as dross. If enough flux is added to form a molten layer which is sufficiently fluid to pour off, the material is referred to as a slag. Most fluxes used in rotary furnaces consist of sodium

and potassium chlorides, usually with a small amount of fluoride to aid wetting. Cover fluxes used in induction furnaces are usually free of sodium and potassium halides.

The main constituents of drosses are usually aluminium oxide (between one-third and nine-tenths), aluminium metal (between a quarter and a half), and the salts used in the original flux. Aluminium nitride and aluminium carbide are likely to be present.

The aluminium present gives hot dross its most obvious characteristic – that of firing readily on exposure to air. Where large amounts of dross are generated it is economical to install a liquid metal recovery system, after which the dross must be cooled quickly to prevent the exothermic reaction. For smaller plants, cooling under an inert atmosphere is appropriate.

Once cooled, the dross can be milled to break down the non-metallic portion and then screened.

The coarse fraction contains sufficient metal to permit recovery in a rotary furnace, using salt flux to separate the non-metallic fraction from the molten metal.

For most operators, present practice is to discard the fines fraction as a special waste since it is not economic to recover the metallic fines, and the non-metallic fines are of very low commercial value.

Where salt slags are generated, salt accounts for about half of the weight and aluminium oxide about a third, with metal lumps usually being much less than a tenth. Small amounts of aluminium carbide and nitride may be present.

The potential environmental impact of discarded slags and drosses is high. This is partly due to the presence of water soluble salts, and partly to the presence of aluminium nitride and carbide. These latter compounds are present in significant concentrations in dross fines, and to a smaller degree in salt slags.

When these compounds become wet they react to form ammonia and methane. They thus present a significant, if local, air pollution hazard and a much more serious water pollution problem should leachate escape from a disposal site. This latter problem would be exacerbated by the presence of dissolved salts.

These potential environmental problems, coupled with economic pressures arising from increased landfill charges, have led companies to develop recovery processes aimed at greatly reducing or even eliminating discharges of special wastes.

The most complex of these has been authorised and is designed to treat both slags and drosses.

In this process the first stage is to crush and screen the material as described above. The fines fraction is then treated to decompose the carbides, nitrides and sulphides associated with

the metallic dust present in the fines. These decompose to yield methane, ammonia and hydrogen sulphide, together with the hydrogen from the dissolution of aluminium.

The ammonia is absorbed to form ammonium sulphate for sale and the remaining gases are burned as fuel to heat the recrystallisation plant, where solution from the crushed slag is recovered.

It is intended that the solid recovered, which is mainly alumina, may be sold. If it is not, then disposal of the now inert material is more acceptable environmentally.

While each of the stages of this process is simple in concept, the materials being processed are highly abrasive and the solutions formed are corrosive. Also, by virtue of the range of sources, dross is very variable in composition.

To date, the combined effect of these problems has prevented reliable operation of the fully integrated recovery process, and at the present state of development it cannot be considered BAT.

Other systems of dross and slag treatment are currently undergoing proving trials. Any application for authorisation of a process which generates such wastes should include a description of the procedure which the operator intends to use to minimise or render them harmless.

Drosses and slags will normally be classified as special wastes due to the aluminium fines, aluminium carbide and nitride. The Agency has produced an Explanatory Note(20) setting out the conditions under which these would be classified as special wastes.

2.8 Production of copper and copper alloys

2.8.1 Manufacture of phosphor copper

Phosphor copper is manufactured by injecting molten or vaporised phosphorous into molten copper. BS 1981.1998 defines five grades of phosphor copper - that with the highest concentration contains between 13.5 and 15% phosphorous. At this concentration the vapour pressure of phosphorous above the melt is very high, and large amounts of dense white phosphorous pentoxide fume are generated both during melting and casting. Any phosphorous in excess of 15% will evaporate and burn off, so the first element of BAT is an effective system of monitoring the quantity of phosphorous added to the molten copper.

Close and effective hooding of the phosphorising pot, together with efficient hooding of the casting spout and moulds, is essential. All pipework should be designed so that any remaining phosphorous drains back to store when phosphorising is complete.

The phosphorous pentoxide present in the exhaust gases will combine with water vapour to produce phosphoric acid mist, some of which will agglomerate on the cooler parts of the duct work. The latter must, therefore, be designed to prevent accumulation of condensate.

The phosphorous pentoxide/phosphoric acid fog generated by this process is very difficult to remove from the exhaust gases. Effective removal requires the use of wet scrubbing followed by a fibre filter, or the use of high-energy venturi scrubbers.

A potential problem with either system may arise from the presence of hydrocarbons in the phosphorous. Under the conditions of the phosphorising pot these decompose to form a greasy soot which has a potential to block the fibre filters. It may also contaminate recovered phosphoric acid, rendering it unsuitable for sale and thereby creating an additional waste stream.

Environmental issues arising from handling and using white phosphorous are discussed in Guidance Note S2.4.04, to which reference should be made.

2.8.2 Smelting low grade scraps and residues using electric heating

The most widely used process for smelting low grade scraps and residues is the blast furnace, as described in CIGN IPR 2/9.

In blast furnaces, the charge is mixed with coke, limestone and sand. Air which is blown in near the bottom reacts with the coke to form carbon monoxide, which in turn acts as a reducing agent to convert copper compounds into copper metal. The coke thus acts both as a heating fuel and as the primary reducing agent.

An alternative process makes use of electric resistance heating to raise the temperature of the charge to working levels, thereby permitting a significant reduction in the amount of coke required in the charge. The volume of off-gases generated during the melting phase is reduced to approximately 15% of those generated by a blast furnace of similar size, although the volumes which must be drawn from secondary sources, such as charging and tap holes, remain essentially unchanged. The electric furnace also requires substantially less cooling water than a blast furnace of similar capacity.

The disadvantages of the electric furnace when compared to the blast furnace are:

- charge preparation is necessary to ensure a uniform particle size;
- the moisture content of the charge must be controlled;
- process control is much more demanding.

Any application for recovering copper from low grade scrap should include a comparison of blast furnace and electric resistance shaft furnace technology.

2.8.3 Melting high purity copper in shaft furnaces

The natural gas-fired shaft furnaces described in CIGN IPR 2/9 were constructed 25 years ago to a design optimised for product quality and thermal efficiency. A primary quality requirement is that there shall be no free oxygen in the

product, thus requiring that there be none in the melting zone. Consequently the burners must be operated fuel-rich.

The vertical shaft design permits the hot gases from the melting zone to give up most of their heat to the descending charge.

The environmental consequences of this design are:

- high concentrations of carbon monoxide in the gases leaving the cupola shaft;
- any carbonaceous material such as drawing lubricant will be subject to destructive distillation yielding VOCs and soot;
- there are negligible amounts of oxides of nitrogen in the exhaust from fuel-rich combustion;
- energy consumption per tonne of production is low.

For existing processes carbon monoxide releases should be minimised by ensuring that burners are effectively controlled and operated with the minimum excess of fuel compatible with ensuring the absence of oxygen. Where necessary the burners should be replaced with more modern types, such as pre-mix burners. These are more easily controlled and can thus be operated closer to the stoichiometric fuel ratio without risk of episodes when free-oxygen is present.

The amount of carbon monoxide likely to be formed from decomposition of oil and grease contamination in the upper shaft is negligible. Authorisation requirements relating to carbon monoxide releases should therefore be based upon the burner monitoring system, for which the 800 mg/m³ figure identified in CIGN IPR 2/9 is not appropriate (see section 4.1.3). Releases of VOCs and particulate should be minimised by scrap selection and cleaning.

In existing furnaces exhaust gases pass the charge hole before exiting through a vertical stack. Substantial dilution takes place at this point, the extent of which is dependent on prevailing weather conditions. Measurements of releases made above the charge hole are therefore subject to considerable variability. This location is thus of only limited value in determining the extent of particulate and VOC emissions arising from charge contamination. A more precise value for the releases of carbon dioxide from these furnaces can be obtained by calculation from the burner control measurement system.

When new furnaces are considered which operate on the same general principles, then the alternative examined should include designs which permit the exhaust gases to be drawn off below the charge hole. This would allow the gases to be passed through an incinerator and waste heat boiler, destroying VOCs and greatly reducing the release of carbon monoxide. Such a furnace would be able to handle scrap contaminated with a higher amount of lubricant. A BPEO assessment should be carried out to identify the preferred option. Such an assessment would be greatly affected by the availability of a consumer for the energy produced.

The benefits, when compared with a top off-take shaft furnace, would be:

- greatly reduced carbon monoxide emissions to air;
- greatly reduced VOC emissions to air;
- potential reduction of high COD wash water if washing plant is used;
- reduced particulate emissions, with further reductions by filtration practicable on the cooled exhaust.

The disadvantages are:

- substantially greater emissions of oxides of nitrogen;
- greater energy use, particularly if no energy consumer is available;
- much more carbon dioxide generated by the need to fuel after-burner.

An alternative system of reducing carbon monoxide releases is to inject air or oxygen into the shaft to achieve after-burning just above the normal burning zone. Such systems are currently under active development.

Results of trials are not yet available, but early indications suggest that carbon monoxide release could be reduced substantially. Such a system could be retro-fitted to existing furnaces more easily than converting the gas off-take system. It does not, however, offer any prospect of significant reduction in the quantity of particulate material discharged.

3 Best available techniques for controlling releases

This section provides additional information on techniques for controlling releases.

The techniques fall into three categories:

- management techniques, relating to the systems and procedures for designing and operating a process;
- process techniques, relating to the use of techniques to reduce releases from activities such as raw material storage, melting and casting;
- abatement techniques, relating to end-of-pipe techniques for releases to air, water and land.

3.1 Management techniques

Effective management is central to environmental performance and is an important component of BAT. It requires an actual commitment to establishing objectives, setting targets, measurement and revision according to results. This systematic approach may be aided by the achievement of management standards such as ISO 14001 and EMAS(21). The following sections provide information on the main types of management technique.

Each of the issues identified in this section should be identified and addressed in the application.

3.1.1 Senior management commitment

Essential features necessary in any environmental management system are that:

- all environmental impacts of activities, products and processes have been identified and considered;
- there is a commitment to conform with statutory regulations as a minimum and work with authorities to develop and implement measures where needed;
- employees and contractors are aware of the commitment and are involved in its delivery;
- effective communication is established with employees and other interested parties.

3.1.2 Organisation and responsibility

There should be a clear structure for managing environmental issues in general and ensuring compliance with the Authorisation in particular. This should be fully integrated with the process operator's wider company and site decision-making systems.

There should be a defined contact point for the IPC Authorisation; usually this requirement can best be met by having a single-point contact. This should be seen as clarifying

the interface between Agency and process operator. It should not reduce the responsibilities of other members of staff for ensuring compliance with the Authorisation.

The environmental performance of the process is highly dependent on the attention and awareness of the process operator's staff. They should be aware of this and their role in the performance made clear. The company should reinforce the message that environmental protection matters. One way to do this is to have environmental performance as a part of annual performance assessments.

Incidents have occurred in the past as a result of poor communication among operations staff during shift changes and maintenance or other engineering work. Specific procedures should be in place to avoid such problems.

The overall environmental performance of the process should be monitored and the results considered on a regular basis, forming part of the management assessment process. Environmental performance indicators (EPIs) should be devised which are relevant to specific activities. For example, where the product does not vary significantly, then releases to the environment could be expressed in terms of mass per unit of production. However, care must be taken to ensure that such measures are meaningful.

A contingency plan should be prepared which identifies the potential types of incident that could occur and provides clear guidance on how they will be managed and who is responsible. In some circumstances it will be necessary to notify the Agency of the incident as a consequence of a condition of the process Authorisation. Such circumstances must be clearly defined, and the persons responsible for notifying the Agency must be also identified. Procedures should be in place to identify, respond to and learn from all complaints and incidents.

Where new processes are being commissioned, or where existing processes are being recommissioned after alterations, a commissioning plan should be prepared. This plan must clearly identify the person responsible for the environmental performance of the process during the commissioning period.

3.1.3 Maintenance

A programme of preventive maintenance should be in place and recorded, coupled with diagnostic testing where appropriate.

Local extraction systems should be examined regularly and defects or damage repaired promptly.

All staff should be aware of the role they can play by maintaining vigilance, for example in relation to damage to hoods and duct work, and appropriate procedures should be in place to encourage staff involvement.

A procedure should be set up to authorise modifications and then undertake follow-up checks before process start-up.

3.1.4 Waste minimisation

Waste minimisation audits should be conducted periodically to a prioritised programme.

The active participation of staff should be encouraged in these initiatives, with recognition given to those who identify waste minimisation improvements.

There should be active monitoring of materials throughput, and appropriate mass balances should be available. Monitoring should include water, power and heat.

3.1.5 Design

The environmental implications of a new process or raw material should be considered at the earliest stages of the project and continue to be reviewed at regular intervals. This is the most cost-effective time to introduce improvements in overall environmental performance. There should be evidence that alternative process options were considered and assessed. An audit trail of the design and decision-making process should be kept.

Potential fugitive releases must be considered at all stages. Techniques for minimising them will vary between processes, but the following should be considered:

- transfers of molten metal between furnaces should be avoided as far as is practicable;
- where such transfers are unavoidable, launders are to be used in preference to ladles;
- hooding and duct work must be designed so as to capture fume arising from hot metal transfers and tapping;
- secondary enclosures may be required to prevent release of primary fume losses into the atmosphere;
- where primary extraction and secondary enclosure are likely to be ineffective, then the building must be fully enclosed and ventilation air drawn off by extraction fans to a suitable discharge system.

In assessing BATNEEC and BPEO, particular attention should be paid to the potential environmental effects of infrequent but essential activities. Examples are:

- the generation and disposal of solid wastes as a consequence of the need to rebuild or reline furnaces;
- the generation of fume and unusual slags when furnaces are "washed out" by firing at high temperatures or with special fluxes in order to remove accumulations of material from within the furnace.

The applicant should consider the process carefully in order to identify activities which require special mention, and the authorisation should include specific reference to all such activities.

3.1.6 Training

Staff should be aware of the implications of the Authorisation for the process and their work activities.

There should be a clear statement of the skills and competencies required for each job.

Training given to staff involved in process operation shall include the environmental implications of their work and the procedures for dealing with incidents.

There should be records of the training given to process operation staff and any other employees whose duties involve operation or monitoring of the process.

3.1.7 Finance and accounting

There should be a good understanding of the costs associated with waste production within the process. This can be achieved by having in place accounting practices that ensure waste disposal and other significant environmental costs are attributed to the processes involved and are not treated simply as a site overhead.

3.1.8 Commissioning

When a new or modified process is to be brought into service, it may be appropriate to apply requirements specific to the commissioning phase. These may include operation of the process in an abnormal manner in order to demonstrate the effectiveness of plant items or systems.

Aspects which should be considered include:

- the applicant or operator should demonstrate that the proposed trial is necessary, and provide information on releases and their environmental impact;
- the principles set out in sections 3.1.1 to 3.1.7 apply to commissioning activities, and, in particular, attention should be paid to the management and training of commissioning staff;
- where release limits set for normal operation can only be met after a period of process optimisation, the operator should provide details of the optimisation procedure to be followed in addition to information concerning potential releases during that period.

Where appropriate, interim release limits should be set which will provide for effective regulation of the process during the commissioning period.

3.2 Process-specific considerations

3.2.1 Foundry operations - mould, core manufacture and sand recovery

The technical and economic feasibility of reclaiming mould/core sand, and the proportion that can be reclaimed, varies between binder systems. In assessing an application or reviewing an Authorisation, the inspector must be satisfied that

BPEO has been achieved. The process operator will need to justify the selection of the core or mould-making system, and type of sand recovery system chosen, bearing in mind the following:

- toxicity to people, and the potential environmental impact of the raw materials to be used. Particular attention should be paid to processes where the use of known carcinogens is proposed;
- the recovery and recycling of sand greatly reduces the quantity of waste produced and must therefore be considered BAT for waste reduction;
- the recovery and recycling plant represents a potential source of air pollution and possibly water pollution, depending upon the process selected. Dry processes utilising crushing and screening operations have a high potential for creating dusty emissions. Thermal processes have the additional potential for VOC releases;
- where organic binders are used and recovery is based upon mechanical attrition, there is a potential for increased generation of fume at the casting stage.

In addition to the above, consideration must also be given to the impact of recycled material upon product quality and, finally, to the costs involved. Detailed advice on optimisation of sand reclamation is given in sections 2.6 and 5.4 of GG 119⁽¹⁸⁾

3.2.2 Casting fume capture

The quantity and nature of the fume generated during casting will depend in part upon the metal to be cast and the mould and core binder systems used, and the sand-to-metal ratio.

The operator should present an assessment of the potential of the proposed system to generate dust, fume and gases during casting and cooling and, where this is not trivial, appropriate control measures should be adopted to prevent significant releases to air. The design of any extraction system employed must be robust and effective for its intended purpose. The points in Section 3.3.1 below will also apply.

3.3 Minimisation and abatement of releases to air

3.3.1 Off gas collection

The design and maintenance of off gas collection systems is of crucial importance in containing gases and preventing fugitive emissions. Any system provided should be matched to the characteristics of the material to be collected, namely the gas volumes, temperatures and pressure, and to their variability. Aspects to be considered are as follows.

(a) Characteristics of material to be collected

Good information is required on the material to be collected so that the system design is appropriate. Aspects to be considered are:

- the characteristics of the material to be collected (volume and temperature, particle size and concentration, abrasiveness of particulate matter, water vapour content);
- the variability of these characteristics. The fume collection and abatement system should be designed to cope with all proposed operations.

(b) Hood design

Sealed furnaces are BAT and should be considered for new applications and any major upgradings. Such furnaces can be charged from sealed lance or burner systems, through hollow electrodes or by docking systems that seal onto the furnace during charging.

Hoods should be designed to be as close as possible to the source of emission, while leaving room for process operations. Moveable hoods can offer a solution when these requirements conflict. Applications should provide details of the capture velocities for each of the hoods.

(c) Dampers

Dampers can be incorporated into systems to target extraction effort, for example on furnaces in operation, or extraction can be varied to suit the operations. Dampers can be automatically controlled to account for cycle disturbances, such as charging and tapping. Where dampers are fitted the control system should include a clear indication of the degree to which any damper is opened. Convenient access for maintenance is also essential.

(d) Duct and fans

Collected gases will be conveyed to abatement plant and emission points by ducts and fans. Ducts should incorporate a good pressure and flow control system. Variable speed fans can provide variable extraction rates with good energy efficiency. Good maintenance of systems is important – they can sometimes be subject to neglect.

(e) System maintenance

Good maintenance of collector hoods, ducts, dampers and fans is vital to ensure optimum collection efficiency. Systems are often vulnerable to being struck and damaged so consequently the design should be robust and allow for the simple replacement of vulnerable parts. In addition there may be physical damage from collisions or from abrasion and loss of efficiency due to dust deposition in ducts or on fan blades. Regular inspection and preventative maintenance is very important.

3.3.2 Control of particulates

Technical Guidance Note (A3) is a primary source of information on BAT in this sector. Techniques that are likely to prove suitable for the control of particulates are:

- cyclones
- filters

Electrostatic precipitators, by virtue of their capital cost and sensitivity to sudden changes in load, are unlikely to be suitable for the processes under consideration. To treat the dense hygroscopic fume generated during the manufacture of phosphor copper, high-efficiency wet scrubbing systems based upon fibre mat filters, or high-pressure Venturi scrubbers, are necessary. In other applications wet scrubbers are unlikely to achieve the collection efficiency of fabric or ceramic filters.

(a) Cyclones

Cyclones are particularly effective for the removal of particles with a diameter $>10\text{ }\mu\text{m}$ and can be used as pre-collectors to protect filters from overloading.

There are two basic types of cyclone:

- reverse flow
- straight through

These are differentiated by the geometry with which the gas stream enters the cyclone. The design of a cyclone will depend upon the particular gas stream that is being dealt with. Recent innovations have seen the development of cyclones containing a rotating impeller to improve removal efficiencies.

(b) Filters

The main variables that are available in designing filters are:

- the filter medium;
- the manner in which the filter is periodically cleaned.

Filter media

Operating experience with ceramic filters is now such that they are an established technology. They should be considered where high-temperature exhausts are generated.

The choice as to whether a ceramic filter is more suitable than a fabric filter in such an application will be influenced by the existence or otherwise of an associated need to filter cooler air from associated locations. An example based upon a small rotary furnace illustrates this point in section 5.3.

When assessing applications involving the use of ceramic filters, the Agency should note that the upper operating temperature may be restricted by the nature of the solids present in the gas stream. For example, salt fume will tend to sinter if temperatures exceed $400\text{ }^{\circ}\text{C}$, likewise aluminium dust at temperatures much in excess of $500\text{ }^{\circ}\text{C}$.

Various fabric filter media are available to deal with a wide range of variables such as temperature, corrosiveness, composition and particle size. Where there is a possibility that "sticky" fume may be generated, such as may arise from the decomposition of organic binders in casting or sand recovery operations, then insufflation with an inert dust may be necessary.

Fabric filters are suitable for collecting fine fume from melting, casting and finishing operations, and also sand and coarse dust from other activities. Inlet temperatures must be controlled, particularly for melting operations where dilution air or heat exchanges may be required. The dilution air can, of course, be drawn from another source, which requires filtration. A spark arrester may also be required.

Ceramic filters are capable of operating at much higher temperatures, often only restricted by the construction materials of the filter body and seals. Excessive temperatures can, however, cause collected dusts to sinter.

Where acid gases are present, filters are likely to benefit from the injection of alkaline powders capable of preventing acid corrosion which will otherwise occur if gas temperature falls below its dew point.

Ceramic and fabric filters can usually achieve efficiencies of greater than 99%, giving final particulate concentrations in exhaust air of 5 mg/m^3 . Table 3.1 summarises some of the more important fabrics that are used as filter media.

Cleaning mechanisms

As particles build up on the surface of the filter they initially aid the filtration mechanism but eventually begin to reduce gas stream throughput and reduce the removal efficiency. To address this problem filters are fitted with cleaning mechanisms that allow the periodic removal of the build-up of particles. There are three main mechanisms for this particle removal from fabric filters, which may be summarised as:

- pulse jet - whereby a pulse of compressed air is applied to the filter in the reverse direction to the normal flow of the gas stream;
- shaker - the bag is shaken to dislodge the particulates;
- reverse flow - clean air is passed through the filter medium in the reverse direction to the normal flow of the gas stream.

Mechanical fragility effectively rules out the use of shakers to clean ceramic filters. Likewise, the rigidity of the filter elements renders simple flow ineffective. Multi-compartment filter systems allow cleaning to be undertaken while the filter is left on-line, improving average performance.

Dust removal

Dust displaced from the bags will fall into a hopper. On small installations the base of the hopper is fitted with a valve which permits the dust to flow into a bin or bags for removal. On

Table 3.1 *Materials utilised in fabric filters*

Common name	Generic name	Chemically resistant to		Maximum normal operating temp (°C)	Maximum peak (°C)	Fire resistance
		Acids	Alkalis			
Cotton	Natural fibre cellulose	Poor	Excellent	80	105	Poor
Polypropylene	Polyolefin	Excellent	Excellent	87	87	Poor
Glass	Glass	Good	Poor	260	287	Good
Nylon	Polyamide	Poor	Excellent	93	121	Poor
Nomex	Aromatic polyamid	Fair	Very good	204	218	Poor
Teflon	Polytetrafluoroethylene (PTFE)	Excellent	Excellent	232	260	Poor
PBI	Polybenzimidazole	Good	Fair	537	649	Poor
Polyester	Polyester	Good	Fair	135	170	Poor
Goretex	PTFE coated fabric	Excellent	Excellent	230	260	Poor
Dralon T	Homopolymer acrylic	Good	Excellent	140		Poor
Bekipor	Stainless steel	Good	Good	454	538	Good

larger installations the collected dust may be removed from below the hoppers by conveyors for transport to silos. Whichever system is used, reasonable clearances must be allowed below the dust removal point to permit easy handling of full containers. Provision should also be made for removal of spillages and accumulations of dust which may build up in the base of hoppers. Control of fugitive emissions should be achieved by sealing collection bags around the discharge pipe, or fitting sealed bins. Care should be taken to avoid wind dispersion of collected dusts.

Operational control of filters

The main issues involved in the control of filters are:

- optimising the frequency of operation of the cleaning cycle;
- managing the operating temperature of the gas stream in order to ensure it doesn't exceed the operating capability of the media, or fall below its dew point;
- monitoring the filter exhaust to ensure the fabric is not split, holed or being bypassed;
- monitoring the air flow through the system to ensure the elements have not become blinded;
- comparison of records of temperature, pressure and fan power consumption during normal operation will enable abnormalities to be identified quickly.

3.3.3 Control of VOC releases

VOC releases arising from storage handling of organic binders and hardeners can be minimised by passing the vapour through a suitable adsorbent, or by utilising the extracted air as primary air on a burner system.

3.3.4 Control of acid gas releases

Acid gases in releases may arise from three sources: as a product of a smelting or refining process, as a result of combustion of fuel or a contaminant, and as a consequence of decomposition of fluxes.

It is now accepted practice to inject alkaline dust into the incoming gas stream where filter plants are used to minimise releases of particulate matter. The dusts adsorb the acid gases present. These systems may be the primary means of preventing releases of the pollutant concerned, such as hydrogen fluoride.

Alternatively, the primary purpose of the system may be to prevent corrosion of the filter plant, such as when filtering exhaust gases from rotary furnaces used to melt aluminium under salt flux. For low concentrations of acid gases associated with fine particles, injection of adsorbent followed by filtration is BAT.

It should be noted that the detail design of the dust entrainment system can have a significant effect upon the adsorption efficiency of these systems.

At one location, an old injection system which inserts dust into a horizontal duct was replaced by one in which the dust is injected into a rising main, and was a factor in reducing releases to one-fifth of the previous level.

Systems for dealing with more concentrated discharges are unchanged.

3.3.5 Dispersion of releases into the atmosphere

The applicant will need to demonstrate that an appropriate assessment of vent and chimney heights has been made, and that they provide adequate dispersion of materials to be released. Initial guidance is given in Technical Guidance Note D1⁽¹³⁾.

For major release points, it is considered BAT for dispersion modelling to be carried out which takes into account local meteorological data, structures and topography, other releases from the process and local background levels. The model should provide estimates of process contribution to ground-level concentrations of significant pollutants at appropriate production and ambient scenarios. The model should also provide overall concentrations for comparison with air quality standards. Operators should provide clear information on the parameters used and the assumptions made in their use of dispersion models. Of particular relevance will be the assessment of the impact of fugitive releases upon background concentrations of pollutants and the fate in the environment of pollutants released. When a significant change is being considered which could lead to an Authorisation variation, for example new plant, uprated existing plant or a major change in new materials, the Agency requires a reassessment of the adequacy of dispersion. This should take into account the proposed changes and show their impact on the environment.

For smaller release points, the guidance given in Technical Guidance Note D1 will normally be sufficient. Release points for which application of the guidance given in D1 indicates the need for a release height in excess of 50 metres should be considered "major".

Where appropriate, the operator should also recognise the chimney or vent as an emergency release point. Process upsets or equipment failure giving rise to abnormally high release levels over short periods should be assessed. Even if a very low probability of occurrence can be demonstrated by the applicant, a value for the chimney or vent height should nevertheless be set to avoid any serious damage to health.

The assessments made by the operator should be validated using the appropriate calculations or dispersion models available to the Agency.

All releases must be controlled and minimised to ensure that ambient air quality beyond the process boundary complies, as a minimum, with air quality standards⁽⁹⁾.

3.3.6 Odours

The potential sources of odorous substances in releases to air should be identified and their significance assessed.

Where a potential exists for odours to be detected outside the site boundary, abatement techniques should take this risk into account.

When resin bound sand is used for cores or moulds, the odour potential should be carefully considered, and the need for extraction to thermal or wet abatement systems assessed.

3.4 Minimisation and treatment of releases to water

Guidance on techniques for the treatment of waste water from IPC processes is given in Technical Guidance Note A4⁽¹²⁾. This Note focuses on the specific requirements of the sector.

Waste water can arise from the process, from storm water, from cooling water, from accidental releases of raw materials or wastes, and from firefighting. These should all be taken into account when preparing or assessing an application.

The sector is characterised by significant variations in waste water quantity and quality. This variability has to be taken into account in the selection of techniques. The initial definition of waste water issues is thus particularly important.

3.4.1 Definition of waste water issues

The definition of waste water issues for a particular process should include the following.

- **Site-specific issues.** These can be represented by the use of plans for sewage, process waste water and surface water run-off systems. The plans should show the interactions between the various systems.
- **Characterisation of all waste streams.** In general this should cover monitoring the main process waste water streams for flow, pH, temperature, chemical oxygen demand (COD), biochemical oxygen demand (BOD) and metallic elements.
- **Defining water use requirements.** This is a necessary step if the reuse/recycle of water is to be maximised and should cover quantity and quality requirements.
- **Listing the materials used on the site and any potential contaminants,** such as oil. This allows the identification of those materials which, while not routinely released in waste water, may enter systems during incidents.
- **Worst-case scenarios.** This involves the derivation of potential "worst-case" combination flow and loads under routine and non-routine conditions.

A major factor to be considered when assessing the process design is the desirability or otherwise of keeping streams segregated. As a general rule, relatively uncontaminated streams such as storm water may be stored for reuse, and should not be contaminated by blending with smaller streams containing significant contamination. Blending streams of differing pH values may reduce the cost of additions where precipitation is used to remove metals from solution.

3.4.2 Water use

The understanding of water use has significant implications for the management of waste water and should be assigned a high priority by the operator. Typical techniques for minimising water use include:

- management practices such as process unit water use targets, audits and publication of water use: product ratios may be appropriate;
- the use of closed-loop cooling systems;
- reuse or recycling of water ;
- regular checks of pipes and valves for leaks, and maintenance where required;
- awareness raising and training of staff.

3.4.3 Abatement technique selection

Once the waste water issues and opportunities for pollution prevention/minimisation have been defined, options for treating (abating) the waste water should be considered.

These are:

- special treatment of segregated streams;
- pre-treatment before central treatment;
- central treatment;
- polishing treatment.

The option selected will be specific to the application under consideration, and shall take account of the nature of the receiving medium, that is sewer or surface water.

3.4.4 Technique screening

A large number of techniques are available and a preliminary screen of the options may be necessary to identify the few that merit detailed consideration. Screening factors may include:

- whether the technique can actually abate the constituents of the waste stream;
- mechanical and operational reliability;
- containment of waste streams;
- cross-media transfer of pollutants;
- downstream sewerage systems and sewage treatment works;
- downstream combined sewer overflows;
- quality and quantity requirements for receiving waters;

- secondary environmental impacts such as noise, odour, visual impairment etc;
- risk of accidents;
- space requirements;
- capital and operating costs;
- energy consumption;
- automation and control.

3.5 Minimisation of waste to land

3.5.1 General

The identification and application of techniques for preventing, minimising and controlling releases to land should reflect the waste management hierarchy.

- Waste arisings should be prevented at source in so far as this is consistent with the overarching requirement to use BPEO. Techniques should include the use of waste minimisation programmes to identify waste prevention opportunities (see section 3.1 on management techniques).
- Where waste arisings cannot be prevented they should be characterised and classified. This should occur at the earliest possible stage in the process and should cover both composition and quantity. Waste characterisation helps identify recycle/reuse opportunities and, where these cannot be applied, allows the development of a suitable programme for handling, storing and disposing of the waste.
- Recycle or reuse opportunities can be identified via a waste minimisation programme. It should be borne in mind that recycling opportunities are not confined to the process.
- A system should be in place to monitor waste arisings on site. This would allow trends to be identified and underpin waste minimisation programmes and disposal practices. The amount of information collected on each waste stream will depend upon the quantity arising, as well as the hazards involved.
- A system should be in place to manage waste arisings. This should cover the use of appropriate storage areas, handling, transportation and disposal. Small quantities of hazardous waste, in particular all waste arising from handling and storage of chemical binders, shall be placed in suitably labelled containers prior to disposal.

Wastes should be sampled and characterised – which may include a detailed analysis – at appropriate frequency to ensure they may be accepted at the waste disposal facility, and so that the relevant information can be made available to the next holder as required by the Duty of Care Regulations⁽³⁾.

3.5.2 Contamination of soil and groundwater

Hard surfacing should be provided in areas where accidental spillage of chemicals may occur, for example in storage areas, and in loading areas. The surfacing should be impermeable to process liquors, and also applies to tank bund floors. This will facilitate recovery and clean-up operations and prevent penetration into the ground.

Hard surfacing of areas subject to potential contamination should be drained so that potentially contaminated surface run-off is not allowed to discharge to ground, which would cause a breach of the requirements of the Groundwater Directive as noted in section 1.5.6 of this Note. Particular care should be taken in areas of inherent sensitivity to groundwater pollution. Poorly maintained drainage systems are in many cases known to be the main cause of groundwater contamination, and surface/above-ground drains are preferred to facilitate leak detection (and to reduce explosion risks).

In addition to sealed bunds, possible measures to reduce contamination from large storage tanks include:

- double-walled tanks
- leak detection channels

These additional measures may be justified in locations of particular environmental sensitivity. Decisions on the measures

to be taken should make allowance for the risk to groundwater, taking into consideration the factors outlined in the Agency document *Policy and Practice for the Protection of Groundwater*⁽¹⁶⁾, including groundwater vulnerability and the presence of groundwater protection zones.

The vulnerability of groundwater to contaminants will depend on the natural characteristics of any given site, specifically on the physical, chemical and biological properties of its soil and rocks. The Agency has produced a series of maps of England and Wales which provide a guide to potential groundwater vulnerability. Source Protection Zones are intended to aid protection by defining annular zones around each major potable source, including springs, boreholes and wells, based on travel times.

Surveys of plant that may continue to contribute to leakage should also be considered as part of an overall environmental management system. In particular, operators should consider undertaking leakage tests and/or integrity surveys to confirm the containment of underground drains and tanks.

4 Benchmark release levels

4.1 Benchmark releases to air

The benchmark release levels below supplement the achievable release levels given in CIGNs IPR 2/4 to 2/12.

The release levels given are achievable by all new processes using the best available techniques described in sections 2 and 3. They should not be applied as uniform release limits, but

should be assessed to take account of site-specific conditions so as to comply with the requirement to use BATNEEC and BPEO and any relevant environmental quality standards.

4.1.1 Releases from non-ferrous foundry operations

The benchmark release levels to air are shown by substance and activity in Table 4.1.

Table 4.1 Benchmark levels for releases to air from foundry operations ^(a)

Source	Emission	Release concentration	Release rate
Storage and transport of sand, including reclaimed sand	Sand and dust	10 mg/m ³ (a)	
Storage handling and use of chemical binders	Volatile organic compounds (VOCs)(b)	20 mg/m ³ (b) 80 mg/m ³ (b)	Total - Class A 100g/h - Class B 2kg/h (b)
Knockout and sand recovery	Sand and dust VOCs	10 mg/m ³ (a) 20 mg/m ³ (b) 80 mg/m ³ (b)	Total - Class A 100g/h - Class B 2kg/h (b)
Shot blasting, fettling and other finishing operations	Sand, dust, metallic particles Metallurgical fume	10mg/m ³ (a)	
Casting station	Metallurgical fume VOCs	10mg/m ³ (a) 20 mg/m ³ (b) 80 mg/m ³ (b)	Total - Class A 100g/h - Class B 2kg/h (b)

- (a) All releases should be essentially colourless, free from persistent trailing mist or fume and free from droplets. Releases from the processes should not give rise to an offensive odour noticeable outside the site where the process is carried on.
- (b) The term "Volatile Organic Compounds" includes all organic compounds released to air in the gas phase. Where it is practicable to do so, the VOCs being released should be identified individually using nomenclature compatible with that of the Inventory of Sources and Releases (ISR) Reporting form devised by the Agency. The VOC concentration levels apply where the total mass release rates are exceeded. Releases below these mass emission rates may not be trivial, and so may still require controls and the setting of appropriate release limits.

4.1.2 Releases from phosphor copper manufacture

For processes in which phosphor copper is manufactured, Table 1 in CIGN IPR 2/9 shall be amended to include:

Phosphorous and its compounds 50mg/m³
calculated as P₂O₅

The reference conditions applicable to this limit are:

Temperature 273 °K (0 °C), pressure 101.3 kPa (1 atmosphere) with no correction for water vapour or oxygen.

This limit shall apply for that part of the cycle which begins when injection of phosphorous begins, and ends when casting is complete.

No emission shall exceed double this value for any sampling period averaged over 15 minutes.

4.1.3 Releases of carbon monoxide

For gas-fired shaft furnaces not fitted with after-burners the benchmark release level for carbon monoxide of Table 1 in CIGN IPR 2/9 shall be amended:

Carbon monoxide 1% (1.25 g/m³)

The reference conditions applicable to this limit are 0% oxygen, dry at 273 °K (0 °C) and 101.3 kPa (1 at atmosphere).

For all other furnaces, the benchmark release level for carbon monoxide shall be 150 mg/m³, under reference conditions of 273 °K (0 °C) and 101.3 kPa (1 atmosphere) and with no correction for water vapour or oxygen.

4.1.4 Releases of zinc from copper processes

For processes in which zinc, or alloys which include zinc, are made or used, Table 1 in section 5.2 of CIGN IPR 2/9 shall be amended to include:

Zinc and its compounds (as Zn) 5 mg/m³.

4.2 Benchmark release levels - surface waters

See Table 4.2.

The list of substances presented in Table 4.2 is not a complete list of those for which limits may be required, neither will all substances listed necessarily require limits.

When assessing the need to include substances within a list for which release limits are defined within a particular authorisation, considerations should include potential impurities in raw materials and to reactive byproducts. The examples below are given by way of illustration.

Table 4.2 Benchmark releases to water

Substance	mg/litre
Total hydrocarbon oil content (IR method)	2
Biological oxygen demand (BOD) (5 day ATU at 20 °C)	2.5
Chemical oxygen demand (COD) (2 hour)	125
Suspended solids (dried at 105 °C)	35
Cadmium expressed as Cd	0.01
Mercury expressed as Hg	0.005

- The above levels are range values achievable after effluent treatment and are not release limits. They are given on the basis of flow-weighted monthly averages.
- Statutory Instrument 1989 No 2286(24) gives limits for releases to water of cadmium and mercury.
- Applicants should note that where discharge to a sewer is proposed, compliance with this requirement of its sewage undertaker does not imply complete compliance with the requirements of BPEO and BATNEEC.

From the copper industry:

Cadmium occurs as a minor impurity in most commercial grades of zinc and will therefore be present as cadmium oxide in metallurgical fume arising during brass manufacture. Spillage of dust collected in filters serving furnaces in which brass is melted or made may permit cadmium to leach into drainage water. Cadmium may also enter the system as a consequence of accidental inclusion of copper cadmium alloys in the raw materials.

From the aluminium industry:

When aluminium is melted, small amounts of aluminium nitride are formed on the surface of the molten metal and included in the dross which is removed before casting. If this dross becomes wet, the nitrides present react to form ammonia which can then contaminate drainage water.

The nature and significance of potential contamination by releases to controlled waters or to sewers will vary on a site-to-site basis, and lists of substances for which release limits are defined will vary accordingly.

4.3 Reliability of test methods

When defining release limits for specific operations the Agency will take into consideration the accuracy, precision and reliability of the monitoring or testing methods which are to be employed to demonstrate compliance.

5 Economic considerations

5.1 Introduction

In determining an application, the Agency must translate BATNEEC and BPEO into conditions to be included in the Authorisation. These criteria require that judgements are made balancing cost against environmental damage, and also concerning the relative significance of discharges to different media. The operator should have presented the reasons why the proposed option is considered to represent BATNEEC and BPEO. The advantages over any other feasible techniques should be identified. The Agency has issued guidance⁽⁷⁾ on the assessment principles of BATNEEC and BPEO.

The cost of controlling releases should not be disproportionate to the environmental benefits delivered. There may be cost savings resulting from changes made to improve environmental performance. BATNEEC is not concerned with the financial health or resources of a particular operator, and excessive costs are viewed in the context of the process and the industry. While techniques and achievable release levels may vary between industry sectors, the same principles apply to all sectors. For existing processes, the timing of improvement programmes may be a factor in the determination of BATNEEC.

5.2 Economic climate

In order to regulate processes in accordance with the principles of BATNEEC, inspectors need to be aware of the economic situation of the respective industries. Currently much of the non-ferrous metallurgical sector, particularly secondary aluminium and copper industries, is struggling with unfavourable conditions such as heavy industrial decline, competition from developing countries, reduced margins and a strong pound.

The aluminium industry, which represents approximately 40% of the non-ferrous sector, has traditionally followed a cyclical pattern. However there have been particular difficulties since 1997. A number of factors, including the overall decline in UK manufacturing industry, the recession in the Far East, an increase in production in Third World countries and the exporting of scrap, have resulted in significant reductions in margins and profits.

The situation is similar in the copper industry. The London Metal Exchange (LME) price of copper has virtually halved between 1995 and 1999.

5.3 Cost information for abatement techniques

5.3.1 Ceramic filters

For processes which generate modest volumes of exhaust gases at high temperatures, ceramic filters are now accepted as proven technology. When comparing costs, however, the total system must be considered, not just the high-temperature

release. By way of illustration consider a simple rotary furnace, melting aluminium under salt flux, and heated by a 36 therm gas air-burner.

The primary exhaust will be 1,122 Nm³/hr at 1,000 °C.

Secondary extraction around the charge door, tapping hood and slice gap required 18,000 Am³/hr at 60 °C.

Option 1 considered is a fabric filter using secondary extraction to cool and dilute the process gas to a temperature at which the fabric will survive:

Resultant volume 23,200 Am³/hr

Resultant temperature 128 °C

At this temperature a Nomex cloth with a filter area of 360m² will be needed. It will also be necessary to fit an effective spark trap.

The estimated cost of Option 1 (erected but excluding ductwork) is £73,000.

Option 2 uses a ceramic filter for the primary exhaust with a fabric filter for the secondary extraction.

As salt flux is being used it is necessary to dilute the primary exhaust so as to reduce the gas temperature below that at which salt will sinter, and block the filter. It is assumed that this can be taken from secondary hoods.

Ceramic filter for process gases (400 °C) - 7,115 Am³/hr.

Price erected - £51,000.

Fabric filter for secondary extraction (233 m² of Nomex bag) (60 °C), 15,000 Am³/hr - £46,000.

Total cost of Option 2 = £97,000.

The cost of ducting has not been included since it is similar in both options.

It is also assumed that duct runs are short and cooling between furnace and filter is negligible.

5.3.2 Sand reclamation

Figures presented in GC 119⁽¹⁸⁾ show that an effective sand recovery system can produce significant financial, as well as environmental, benefits. It quotes a small non-ferrous foundry operating an alkali phenolic binder system with new sand. All processed sand was disposed of as waste. A mechanical recovery system capable of recovering 800 tonnes (of the 1,000 tonnes) per year of the sand used was installed. Reduced raw material charges and disposal costs yielded a net saving of £20,000 per year.

6 Monitoring

6.1 General

There is an expanding series of HMIP and Environment Agency Technical Guidance Notes on monitoring, containing information on theory and methodology and providing technical information on monitoring techniques (see Associated publications in this Note).

Reference should be made to the application when setting standards of release in Authorisations to ensure that such conditions are assessable by means described by the applicant, and are properly enforceable. In particular, when defining release limits inspectors should take into account the availability of suitable monitors, and the precision and accuracy of both continuous monitors and calibration methods.

Particular attention should be paid to features that give rise to fugitive releases. Frequently these are the result of poor extraction, which is in turn a result of poor filter performance of fans, filters or ductwork.

Leaks in ducts which permit air to enter the system between the emission source and the filtration plant can contribute to poor extraction plant performance. Furnace exhaust systems where the ductwork is subjected to high and variable temperatures are particularly prone to air ingress. Checks can be made by testing the exhaust gases for carbon dioxide at a point close to the source and comparing it with the concentration present on the discharge side of the filter. From these figures the quantity of clean air being drawn into the filter can be calculated.

Facilities for such checks should be designed into the system and regular checks instituted if there is evidence of fugitive releases.

Where there is a significant potential for fugitive releases into the air, long path monitoring systems fitted above furnaces are a practicable means of assessing the level of performance. Other methods of assessing and monitoring the extent of fugitive emissions include time lapse photography (which is particularly useful for assessing the volume of fume generated when metal is being poured) and infra red photography (which can be used when hot gases escape). An assessment of the quantity of material being lost can be made by sampling the air being discharged through roof vents, though estimates of the volumetric rate will be significantly less accurate than for ducted releases.

6.2 Systems monitoring

Monitoring should not be restricted to systems that assess direct releases into the environment. Secondary measurements such as pressure drops and power consumption should supplement direct release assessments, and in some cases may be an acceptable surrogate. In all cases consideration should be given to the demonstration of the proper functioning of the process and abatement plant.

Monitoring should be undertaken during commissioning, start-up, normal operation and shut-down unless the inspector agrees that it would be inappropriate to do so. The manner in which results are obtained during commissioning, start-up and shut-down are reported should be defined by the inspector.

6.3 Monitoring of releases to air

6.3.1 Continuous monitors

Where appropriate, continuous monitoring techniques should be used commensurate with the limitations and accuracy of continuous monitors. When continuous monitoring is not appropriate or available, non-continuous monitoring should be undertaken, together with surrogate measurements where applicable.

The Agency has established its Monitoring Certification Scheme (MCERTS). Continuous emission monitoring systems should be expected to meet the performance standards published under the Scheme. Manual stack testing should be reported using the Agency's standard reporting formats. MCERTS performance standards are currently being developed and should be given due consideration when available.

Of particular relevance is the Agency report *A Review of the Industrial Uses of Continuous Monitoring Systems: Metals Industry Processes*⁽¹⁵⁾. Section 3.2.2.2 of this review should be noted when assessing the need for and value of continuous monitors used to measure particulate concentrations.

All types of particulate continuous monitor are influenced to a greater or lesser degree by changes in the particle size distribution of the emitted material. When a filter plant fails, for example through rupture of fabric, then in most applications there will be a dramatic change in the particle size distribution of the emitted material. Consequently particulate monitors can give only semi-quantitative indications of releases during failure.

Table 3.1 of the above review, which summarises the sources of potential errors, is reproduced below. Inspectors should also take note of the comments regarding the precision and accuracy of available standard reference methods that would be required to calibrate monitors. Standard reference methods, if competently applied, will provide results to a specified degree of accuracy and precision under a wide range of conditions. Routine checks, on the other hand, may be very simple and involve a different principle of operation. They will need to be proven for each process and set of circumstances. Inspectors should be aware that simplified methods used for routine checks will be less precise and less accurate than reference methods.

Where continuous monitors are fitted, release limits are normally set on the basis of 95% of the hourly average readings for each rolling 24-hour period not exceeding the value (or alternatively not more than one hourly average reading in any rolling 24-hour period exceeding this value), and that the maximum hourly average figure shall not exceed 150% of this value.

In order to relate emission concentrations to mass releases, it will be necessary to measure or otherwise determine the gas flow. Additionally, temperatures will need to be determined in order to relate measurements to reference conditions. All such measurements should be recorded.

6.3.2 Sampling and analysis

The frequencies that operators are required to sample environmental discharges will vary. Typically frequencies will be in the range from quarterly to every six months, but they should be set in proportion to environmental risk.

In selecting appropriate sampling frequencies, consideration should be given to:

- the mass release rate;
- the toxicity of the potential release;
- the ability of the local environment to withstand the expected level of discharges;
- the nature and sensitivity of local receptors;
- the presence of effective and reliable continuous release monitors;
- the extent to which other process parameters can be relied upon to indicate correct operation.

Particular consideration should be given to variable discharges, such as in batch operations. Sampling periods must be designed to give an accurate picture of the performance of the process, with samples taken which represent both peak and average performance. The peak sampling period should not be of more than one hour's duration and shall include the period of maximum emission. The average sampling period shall include the period of maximum emission, but may be extended to include the whole operating cycle.

The Agency will normally carry out periodic check monitoring for key substances. This will be at a lower frequency than the operators' discharge sampling. The monitoring frequency should typically be annual, but in setting frequencies the Agency will take into account the potential for releases from the process and their possible environmental impact.

6.3.3 Particulates

Potential releases of particulate matter into the atmosphere may be particularly coarse, such as those arising from materials handling operations, or they may be very fine, such as fume formed from molten metal or fluxes. Likewise the potential for

release may be almost constant for long periods, such as from an electrolytic reduction cell used to manufacture aluminium, or may vary substantially over a short period of time. All continuous particulate monitoring systems are affected to a greater or lesser degree by the physical characteristics of the particles being emitted and, where this can vary, any calibrations should be treated with caution.

Monitoring procedures must take into account this variability, the effectiveness of continuous monitors under the circumstances in which they are to operate, the scale of the operation and the potential consequences of a failure remaining undetected.

6.3.4 Dioxins

Some non-ferrous metal processes will have the potential for the release of dioxins, in particular where there may be the presence of chlorine-containing compounds in the input materials (for example contaminated scrap) or chlorine-containing fluxes. In the event of either of these being possible, the following approach should be taken:

- the "worst-case" situation should be monitored performing a test, taking at least three samples;
- if the average of the three samples represents a concentration of $>0.1 \text{ ng TEQ/m}^3$ and/or $>0.01 \text{ g TEQ/annum}$, monitoring and reporting requirements should be in place;
- monitoring and reporting should be based on between four and six tests per year for the first year, followed by tests every six months or more frequently, as appropriate.

Monitoring frequencies should be reviewed in the event of any changes to the process which may have the potential to change the quantities of dioxins produced.

At the time of writing (mid-1999) US EPA Method 23 and CEN Standards are acceptable monitoring methodologies. However, operators should liaise with the Agency to ascertain the up-to-date position.

Table 6.1 Overview of particulate measurement techniques

Reproduced from Table 3.1 of the Agency report *A Review of the Industrial Uses of Continuous Monitoring Systems: Metals Industry Processes* ⁽²⁵⁾

Type	Sensitivity	Influences	Problems/advantages
Transmissivity (opacity)	Range limited to approximately 100 mg/m ³ Output is related to concentration, not mass emission	Particle size Particle shape Particle colour Ambient light	Dirt on lenses windows Misalignment of the transmitter and receiver reflector units owing to thermal expansion of duct
Scattering	Output is related to concentration, not mass emission Not suitable for high-opacity applications such as smoke	Particle size Particle shape Particle colour Ambient light	Dirt on lenses windows, although less sensitive to this than the transmissivity type
Optical scintillation	AC measurement Higher sensitivity than transmissivity type Response is related to mass emission (velocity dependent)	Particle size Particle shape Particle emission reflection effects Dynamic flow conditions	Dirt on lenses windows although less sensitive than the transmissivity type Suitable for small and large diameter ducts
Triboelectric	DC or AC measurement High sensitivity DC type. Response is related to mass emission (velocity dependent) AC type. Response is related to concentration (velocity independent)	Particle size Particle shape Particle electrostatic characteristics Duct electrostatic characteristics Dynamic flow conditions	Not suitable for damp or wet gas Influenced by ionisation and humidity variations Will tolerate superficial contamination (AC type high tolerance) Applicable to small diameter ducts down to 100 mm
Acoustic	Moderate sensitivity Response is related to mass emission Alarm duty only	Particle mechanical characteristics Dust geometry Dynamic flow conditions Ambient noise	Complex and application dependent

6.4 Monitoring releases to surface water

Continuous-monitoring and flow proportional sampling are always preferable but fixed-interval or time-proportional samples may be used where flow rates are less than 1 litre per second.

Process effluents released to controlled waters or sewers should normally be monitored for the following:

- flow rate
- pH
- temperature

- relevant metals
- oil content
- BOD
- COD
- suspended solids

In addition to the monitoring carried out by the operator to demonstrate compliance with the release limits set, the operator should have fuller analysis carried out covering a broad spectrum of substances to ensure that the discharge is

not harmful. The range of substances to be determined and the frequency with which such exercises are necessary shall be determined by the Agency after considering the range of materials used, and the possible environmental impact of releases.

6.5 Monitoring releases to land

6.5.1 To ensure safe handling and disposal of wastes

The applicant should record and advise the Agency of the quantity and composition of waste released to land. This advice should identify and quantify any prescribed substances which are present.

The applicant should have written procedures which ensure releases are handled, treated and disposed of in an approved manner, and specify how the accumulation and storage of waste are controlled.

The frequency of analysis of the waste is site-specific, influenced by considerations of the anticipated quantity, its frequency of despatch from the site, physical form, containment (for transport) and composition. Applicants should be aware the Agency will wish to be satisfied that analyses are sufficient to ensure wastes are acceptable under the terms of the Waste Management Licence of the facility where they are to be disposed of and fulfil the waste description requirements of the Duty of Care.

6.5.2 To ensure effective waste minimisation

In order to minimise the amount of waste generated by the process, the point of origin within the process should be identified. Waste should be classified according to the activity which gave rise to the waste and, in particular, wastes arising from failures and operational problems should be separately identified.

6.6 Environmental monitoring

6.6.1 Solid waste disposal

Solid wastes arising from the process must be disposed of to holders of Waste Management Licences and their environmental impact will be considered, and if necessary monitored by the relevant licence holder.

Operators should ensure that sufficient information is made available to licence holders to carry out this duty.

6.6.2 Aqueous discharges

The environmental impact of discharges to water may be potentially reversible, such as those caused by warm water, pH exceedance or high BOD. Alternatively, they may lead to accumulations of toxic materials in water courses.

The extent to which monitoring or surveying the aquatic environment is necessary will depend upon the nature of the water course and on other potential sources of pollution, as

well as the process under consideration and the effectiveness of process monitoring systems.

The applicant should identify potential impacts and provide an assessment of the potential value of monitoring them. Monitoring or surveying may include biological as well as chemical procedures.

6.6.3 Atmospheric monitoring

The nature of most non-ferrous metals operations is such that a significant portion of the release to atmosphere can be by routes other than designated release points. Ascertaining the magnitude and modelling the environmental impacts of such fugitive releases is much less effective than for stack releases, and environmental monitoring may be required. This is particularly so when emissions contain significant amounts of materials for which air quality standards are extant.

The design of the monitoring programme should take account of any existing monitoring networks operated by or on behalf of central or local government, and sampling systems must be designed so that the data can be compared directly with the requirements of air quality standards.

Where a number of different sources could influence air quality at a particular location, then directional monitors can be used to identify the respective contributions.

These monitors are similar to normal monitors but their operation is automatically linked to wind direction, so they only sample when the wind comes from a pre-determined arc, and exceeds a given strength. They should be fitted with data loggers to identify periods of operation.

6.7 Groundwater impact

Where on-site disposals are made, or where there are discharges to groundwater, either directly or indirectly, the requirements of the Groundwater Directive for "prior investigation" of the potential effects on groundwater and "requisite surveillance" need to be addressed. The form these will take will depend on circumstances, but it may be appropriate to include a structured programme of groundwater monitoring, for example using borehole monitoring.

In addition, where there is reason to suspect that leakage of chemicals to ground may have occurred or may be occurring, a programme of investigations should be instigated and preferably agreed with the Agency (some activities may require the Agency's prior consent).

For many sites it will be appropriate to incorporate a programme of background monitoring of groundwater to ascertain whether the process has given rise through time to groundwater contamination via leaking pipes, accidental spills, contaminated run-off etc. This is over and above any monitoring required to monitor the effects of specific on-site disposals of solids or liquids on groundwater. Owing to the lengthy residence time and differing modes of transport and degradation in the underground environment, such monitoring

is likely to be long-term and should be adapted to the types of contaminant that could be present in the potential discharges. It is essential to include background monitoring of groundwater that has not been affected by site processes (normally up-gradient in the hydraulic sense) to determine objectively the degree of contamination that may be attributable to site processes.

It should be noted that, due to the variety of flow mechanisms, background water quality and modes of transport in the subsurface environment, the sampling methods and frequencies

and the determinands to be measured should be assessed on a site-specific basis and following consultation with a suitably qualified hydrogeologist.

In setting out a programme of investigations, and when interpreting the results, operators should take account of the specific risks to groundwater and seek advice from the Agency in cases of uncertainty.

Abbreviations and definitions of terms used

BAT	Best available technique(s)	EPI	Environmental Performance Indicators
BATNEEC	Best available techniques not entailing excessive cost	HMIP	Her Majesty's Inspectorate of Pollution
BPEO	Best practicable environmental option	HSE	Health and Safety Executive
BOD	Biochemical oxygen demand	IPC	Integrated Pollution Control
CO	Carbon monoxide	IPPC	Integrated Pollution Prevention and Control
COD	Chemical oxygen demand	ISO	International Standard Organisation
EMAS	ECO-Management and Audit Scheme	UNECE	United Nations Economic Commission: Europe
EPA90	The Environmental Protection Act 1990	VOC	Volatile organic compounds

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| <p>(14) EC Directive relating to 1,2-dichloroethane, trichloroethylene, perchloroethylene and trichlorobenzene 90/415/EEC</p> <p>(15) <i>The Surface Waters (Dangerous Substances Classification) Regulations 1989</i> SI 1989 No 2286</p> <p><i>The Surface Waters (Dangerous Substances Classification) Regulations 1998</i> SI 1998 No 389</p> <p>(16) <i>Policy and Practice for the protection of Groundwater.</i> Environment Agency, SO, 1998 ISBN 0-11-310145-7</p> <p>(17) <i>EC Directive on the Protection of Groundwater against Pollution Caused by Certain Dangerous Substances.</i> 80/68/EEC</p> <p>(18) <i>The Environmental Technology Best Practice Programme</i>, ETSU, Harwell, Oxfordshire OX11 0RA.</p> <p>Helpline 0800 585794</p> <p>Good Practice Guides</p> <p>GG104 Cost Effective Management of Chemical Binders in foundries.</p> <p>GG71 Cost-effective reduction of fugitive solvent emissions</p> <p>GG119 Optimising sand use in foundries.</p> | <p>(19) <i>Pollution Control in the Primary Aluminium Industry</i> DOE Report Number DOE/HMIP/RR/93/029 April 1993.</p> <p>(20) <i>Aluminium Drosses & Slags & Related Wastes. Special Wastes Explanatory Note.</i> SWEN 042. Environment Agency, 1 January 1999</p> <p>(21) International Standards Organisation (ISO), <i>Standard for Environmental Management Systems, ISO 14001</i></p> <p>Regulation (1836/93) allowing voluntary participation by companies in the industrial sector in a Community eco-management and audit scheme (EMAS). <i>Official Journal</i>, L168/1, 10/7/93</p> <p>(22) <i>Technical Guidance Note (Abatement) A4: Effluent Treatment Techniques (TSO)</i> January 1997. £28.00 ISBN 0-11-086819-6</p> <p>(23) <i>The Collection and Disposal of Waste Regulations 1988.</i> SI No 819. ISBN 0-11-310134-1</p> <p>(24) SI 1989 No. 2286</p> <p>(25) <i>A Review of the Industrial Uses of Continuous Monitoring Systems; Metals Industries Processes;</i> Environment Agency Report No NCAS/TR/98/003 March 1998.</p> |
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Associated publications

The following are available from Stationery Office bookshops (see back cover), their accredited agents, and some larger bookshops.

Series 2

Chief Inspector's Guidance Notes (prepared by Her Majesty's Inspectorate of Pollution)

Fuel production processes, combustion processes (including power generation)

S2 1.01 Combustion processes: large boilers and furnaces 50 MW(th) and over

November 1995, £9.95, ISBN 0-11-753206-1

Supersedes IPR 1/1

IPR 1/2 Combustion processes: gas turbines

September 1994, £4.00, ISBN 0-11-752954-0

S2 1.03 Combustion processes: compression ignition engines 50 MW(th) and over

September 1995, £7.95, ISBN 0-11-753166-9

Supersedes IPR 1/3

S2 1.04 Combustion processes: waste and recovered oil burners 3 MW(th) and over

September 1995, £7.95, ISBN 0-11-753167-7

Supersedes IPR 1/4

S2 1.05 Combustion processes: combustion of fuel manufactured from or comprised of solid waste in appliances 3 MW(th) and over

September 1995, £9.95, ISBN 0-11-753168-5

Supersedes IPR 1/5 - 1/8

S2 1.06 Carbonisation processes: coke manufacture

September 1995, £9.95, ISBN 0-11-753176-6

Supersedes IPR 1/9

S2 1.07 Carbonisation and associated processes: smokeless fuel, activated carbon and carbon black manufacture

September 1995, £9.95, ISBN 0-11-753177-4

Supersedes IPR 1/10

S2 1.08 Gasification processes: gasification of solid and liquid feedstocks

November 1995, £9.95, ISBN 0-11-753202-9

Supersedes IPR 1/11

S2 1.09 Gasification processes: refining of natural gas

November 1995, £9.95, ISBN 0-11-753202-7

Supersedes IPR 1/12 and 1/13

S2 1.10 Petroleum processes: oil refining and associated processes

November 1995, £14.00, ISBN 0-11-753204-5

Supersedes IPR 1/14 and 1/15

S2 1.11 Petroleum processes: on-shore oil production

November 1995, £8.25, ISBN 0-11-753205-3

Supersedes IPR 1/16

S2 1.12 Combustion processes: reheat and heat treatment furnaces 50 MW(th) and over

September 1995, £8.50, ISBN 0-11-753178-2

Supersedes IPR 1/17

IPC Guidance Notes (prepared by the Environment Agency)

Metals production and processing

S2 2.01 Iron and steel making processes

September 1999, £60, ISBN 0 11 310163 5

Supersedes IPR 2/1 and IPR 2/3

S2 2.02 Ferrous foundries: supplementary guidance

September 1999, £60, ISBN 0 11 310164 3

Supplements IPR 2/2

Mineral industry sector

S2 3.01 Cement manufacture, lime manufacture and associated processes

August 1996, £21.00, ISBN 0-11-310120-1

Supersedes IPR 3/1 and IPR 3/2

S2 3.02 Asbestos processes

August 1996, £15.00, ISBN 0-11-310118-X

Supersedes IPR 3/3

S2 3.03 Manufacture of glass fibres, other non-asbestos mineral fibres, glass frit, enamel frit and associated processes

August 1996, £21.00, ISBN 0-11-310121-X

Supersedes IPR 3/4 and IPR 3/5

S2 3.04 Ceramic processes

August 1996, £17.00, ISBN 0-11-310119-8

Supersedes IPR 3/6

Chemical industry sector

S2 4.01 Large-volume organic chemicals

January 1999, £40.00, ISBN 0-11-310141-4

Supersedes IPR 4/1 to 4/4 and 4/6

S2 4.02 Speciality organic chemicals

January 1999, £40.00, ISBN 0-11 310154 6

Supersedes IPR 4/5, 4/7 to 4/9, 4/12 and 4/15

S2 4.03 Inorganic acids and halogens

January 1999, £40.00, ISBN 0-11 310140-6

Supersedes IPR 4/10, 4/11, 4/13 and 4/14

S2 4.04 Inorganic chemicals

January 1999, £40.00, ISBN 0-11-310153-8

Supersedes IPR 4/16 and 4/18 to 4/25

Waste disposal and recycling sector

S2 5.01 Waste incineration

August 1996, £30.00, ISBN 0-11-310117-1

Supersedes IPR 5/1, 5/2, 5/3, 5/4, 5/5 and 5/11

S2 5.02 Making solid fuel from waste

July 1996, £15.00, ISBN 0-11-310114-7

Supersedes IPR 5/6

S2 5.03 Cleaning and regeneration of carbon

July 1996, £13.00, ISBN 0-11-310115-5

Supersedes IPR 5/7

S2 5.04 Recovery of organic solvents and oil by distillation

July 1996, £17.00, ISBN 0-11-310116-3

Supersedes IPR 5/8 and IPR 5/10

Series 1

Chief Inspector's Guidance Notes (prepared by Her Majesty's Inspectorate of Pollution)

Metals production and processing

The following Metals Guidance Notes are available on the Agency Internet Website.

<http://www.environment-agency.gov.uk/epns>

IPR2/2 Ferrous foundry processes

October 1994, £10.00, ISBN 0-11-752962-1

IPR2/4 Processes for the production of zinc and zinc alloys

November 1994, £7.50, ISBN 0-11-753024-7

IPR2/5 Processes for the production of lead and lead alloys

November 1994, £7.50, ISBN 0-11-753025-5

IPR2/6 Processes for the production of refractory metals

November 1994, £6.50, ISBN 0-11-753026-3

IPR2/7 Processes for the production, melting and recovery of cadmium, mercury and their alloys

November 1994, £7.00, ISBN 0-11-753027-1

IPR2/8 Processes for the production of aluminium

November 1994, £8.50, ISBN 0-11-753028-X

IPR2/9 Processes for the production of copper and copper alloys

November 1994, £7.00, ISBN 0-11-753029-8

IPR2/10 Processes for the production of precious metals and platinum group metals

November 1994, £8.00, ISBN 0-11-753030-1

IPR2/11 The extraction of nickel by the carbonyl process and the production of cobalt and nickel alloys

November 1994, £7.50, ISBN 0-11-753031-X

IPR2/12 Tin and bismuth processes

November 1994, £7.50, ISBN 0-11-753032-8

Waste and recycling sector

IPR5/9 Regeneration of ion exchange resins

May 1992, £4.30, ISBN 0-11-752650-9

Other industries

IPR6/1 Application or removal of tributyltin or triphenyltin coatings at shipyards or boatyards

March 1995, £6.00, ISBN 0-11-753079-4

IPR6/2 Tar and bitumen processes

March 1995, £7.00, ISBN 0-11-753080-8

IPR6/3 Timber preservation processes

March 1995, £6.00, ISBN 0-11-753081-6

IPR6/4 Di-isocyanate manufacture

March 1995, £8.00, ISBN 0-11-753082-4

IPR6/5 Toluene di-isocyanate use and flame bonding of polyurethanes

March 1995, £7.00, ISBN 0-11-753083-2

IPR6/6 Textile treatment processes

March 1995, £7.00, ISBN 0-11-753084-0

IPR6/7 Processing of animal hides and skins

March 1995, £7.00, ISBN 0-11-753085-9

IPR6/8 The making of paper pulp by chemical methods

May 1995, £8.50, ISBN 0-11-753105-7

IPR6/9 Paper making and related processes, including mechanical pulping, recycled fibres and de-inking

May 1995, £10.00, ISBN 0-11-753106-5

Technical Guidance Notes

Monitoring

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

August 1995, £11.00, ISBN 0-11-753134-0

M5 Routine measurement of gamma ray air kerma rate in the environment
September 1995, £11.00, ISBN 0-11-753132-4

Dispersion

D1 Guidelines on discharge stack heights for polluting emissions
July 1993, £8.00, ISBN 0-11-752794-7

Abatement

A1 Guidance on effective flaring in the gas, petroleum, petrochemical and
associated industries
December 1993, £4.25, ISBN 0-11-752916-8

A2 Pollution abatement technology for the reduction of solvent vapour
emissions
October 1994, £5.00, ISBN 0-11-752925-7

A3 Pollution abatement technology for particulate and trace gas removal
April 1994, £15.00, ISBN 0-11-752983-4

A4 Effluent treatment techniques
January 1997, £28.00 ISBN 0-11-310127-9

A5 Abatement of atmospheric radioactive releases from nuclear facilities
1998, £50.00, ISBN 0-11-310134-1

Environmental

E1 Best practicable environmental option assessments for Integrated Pollution
Control
April 1997, £35.00, ISBN 0-11-310126-0

Relevant DETR publications

Integrated Pollution Control: a practical guide.

DETR, 1995, ISBN 1-85112-021-1. Available from:

DETR Publications Sales Centre
Unit 8
Goldthorpe Industrial Estate
Goldthorpe
Rotherham
S63 9BL

Tel: 01709 891 318

Secretary of State's Process Guidance Notes

Processes Prescribed for Air Pollution Control by Local Authorities

A list of these notes is available from:

Department of the Environment, Transport and the
Regions
Air and Environmental Quality Division
Ashdown House
123 Victoria Street
London
SW1E 6DE

Tel: 0171 890 6333

MANAGEMENT AND CONTACTS:

The Environment Agency delivers a service to its customers, with the emphasis on authority and accountability at the most local level possible. It aims to be cost-effective and efficient and to offer the best service and value for money.

Head Office is responsible for overall policy and relationships with national bodies including Government.

Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol BS32 4UD
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Fax: 01222 798 555



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ENVIRONMENT AGENCY GENERAL ENQUIRY LINE

0645 333 111

The 24-hour emergency hotline number for reporting all environmental incidents relating to air, land and water.

ENVIRONMENT AGENCY EMERGENCY HOTLINE

0800 80 70 60



**ENVIRONMENT
AGENCY**

The Environment Agency has a commitment to follow developments in technology and techniques for preventing or minimising, or remedying or mitigating the effects of pollution of the environment. It publishes information provided to its staff, in the form of Guidance Notes, to make it available to potential operators and other interested parties.

This Note supplements the original Integrated Pollution Guidance Notes on non-ferrous metals processes. In addition to providing updated information, new sections on management techniques, groundwater protection and sectoral economics have been included.

