Technical Guidance Note

IPPC S2.02

Integrated Pollution Prevention and Control (IPPC)

Technical Guidance for Non-Ferrous Metals and the Production of Carbon and Graphite

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Note:

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Executive summary

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

What is IPPC ?

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

The Agencies intend to implement IPPC to:

- protect the environment as a whole
- promote the use of "clean technology" to minimise waste at source
- encourage innovation, by making industrial operators responsible for developing solutions to environmental issues
- provide a "one-stop shop" for administering applications for Permits to operate.

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

This Guidance and the BREF

This UK Guidance for delivering the PPC (IPPC) Regulations in the Non-Ferrous Metals sector is based on the BAT Reference document BREF (see Ref. 3) produced by the European Commission. The BREF is the result of an exchange of information between member states and industry. The quality, comprehensiveness and usefulness of the BREF is acknowledged. This Guidance is designed to complement the BREF and is cross-referenced to it throughout. It takes into account the information contained in the BREF and lays down the standards and expectations in the UK (England and Wales, Scotland and Northern Ireland) for the techniques and standards that need to be addressed to satisfy the Regulations. The reader is advised to have access to the BREF.

The aims of this Guidance

The aims of this Guidance are to:

- provide a clear structure and methodology for operators to follow when making an application to ensure that all aspects of the PPC Regulations (see Appendix 2 for equivalent legislation in Scotland and Northern Ireland) and other relevant Regulations have been addressed (see Section 1.3);
- minimise the effort by both Operator and Regulator in the permitting of an installation by use of clear indicative standards and the use of material from previous applications and from accredited Environmental Management Systems (EMS);
- improve the consistency of applications;
- increase the transparency of the permitting process by having a structure in which the Operator's response to each issue, and any departures from the standards, can be seen clearly;
- improve consistency of regulation across installations and sectors by facilitating the comparison of applications;
- provide a summary of some BAT techniques for pollution control which are common to all sectors, expressed, as clear indicative standards which need to be addressed by applicants;
- provide an arrangement of information which allows the reader to find, quickly, all of the guidance associated with:
    - a subject (e.g. accidents, energy or noise) (Sections 2.1 and 2.5–2.11);
    - the technical areas (e.g. smelting or effluent treatment) (Sections 2.3–2.4);
    - particular emissions (e.g. gases or particulate) (Section 3).

To assist Operators in making applications, separate technical guidance is also available on a range of topics such as waste minimisation, monitoring, calculating stack heights. The majority of this guidance is available free through the Environment Agency, SEPA or EHS (Northern Ireland) web sites (see References).

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1 INTRODUCTION

1.1 Understanding IPPC and BAT

IPPC and the Regulations

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

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

IPPC operates under the Pollution Prevention and Control (England and Wales) Regulations (see Ref. 2 and Appendix 2). These Regulations have been made under the Pollution Prevention and Control (PPC) Act 1999 (see Ref. 1) and implement the EC Directive 96/61 on IPPC. Further information on the overall system of IPPC, together with Government policy and more detailed advice on the interpretation of the Regulations, can be found in the Department for Environment, Food and Rural Affairs (DEFRA) document *IPPC: A Practical Guide* (see Ref. 5).

Installation-based, NOT national emission limits

The "BAT" approach of IPPC is different from regulatory approaches based on fixed national emission limits (except where General Binding Rules have been issued by the Secretary of State). The legal instrument which ultimately defines BAT is the Permit and this can only be issued at the installation level.

Indicative BAT standards

Indicative BAT standards are laid out in national Guidance (such as this) and should be applied unless there is strong justification for another course of action. It should be noted that BAT includes both the technical components of the installation given in Section 2 and the benchmark release levels quoted in Section 3. (The definitive interpretation of "best available techniques", which also includes the way in which the installation is designed, built, maintained, operated and decommissioned, appears in Section 3 of the Regulations (SI 2000 No 1973).) Departures from these standards may be required to take account of the technical characteristics of the installation, and its geographical location or local environmental conditions. All such departures, in whichever direction, must be justified at the local level. Notwithstanding this, if there are any applicable mandatory EU emission limits, they must be met first, although BAT may exceed them.

BAT and EQSs

The "BAT" approach is also different from, but complementary to, regulatory approaches based on environmental quality standards (EQS). Essentially BAT requires measures to be taken to **prevent** or, where this is not practicable, to reduce emissions. That is, if emissions can be reduced further, or prevented altogether, at reasonable cost, then this should be done **irrespective** of whether any environmental quality standards are already being met. It requires us not to consider the environment as a recipient of pollutants and waste, which can be filled up to a given level, but to do all that is practicable to minimise the impact of industrial activities. The process considers what can be reasonably achieved within the installation first (this is covered by Sections 2 and 3 of this Guidance) and only then checks to ensure that the local environmental conditions are secure (Section 4 of this Guidance and Ref. 7). The BAT approach is, in this respect, a more precautionary one, which may go beyond the requirements of environmental quality standards.

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

Advice on the relationship of environmental quality standards and other standards and obligations is given in *IPPC: A Practical Guide* (see Ref. 5) and in Section 3.

Assessing BAT at the sector level

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

Assessing BAT at the installation level

When assessing the applicability of the sectoral, indicative BAT standards at the installation level, departures may be justified in either direction as described above. The most appropriate technique may depend upon local factors and, where the answer is not self-evident, a local assessment of the costs and benefits of the available options may be needed to establish the best option. Individual company profitability is **not** considered.

In summary, departures may be justified on the grounds of the technical characteristics of the installation concerned, its geographical location and the local environmental conditions but not on grounds of individual company profitability. Further information on this can be found in the Guide for Applicants (see Refs. 5 and 6).

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

- where the BAT cost/benefit balance of an improvement only becomes favourable when the relevant item of plant is due for renewal/renovation anyway (e.g. BAT for the sector may be to change to a different design of furnace when a furnace comes up for rebuild). In effect, these are cases where BAT for the sector can be expressed in terms of local investment cycles.
- where a number of expensive improvements are needed, a phasing programme may be appropriate as long as it is not so long as to be seen as rewarding a poorly performing installation (see Ref. 7 for more details).

Innovation

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

New installations

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

Existing installations– standards

For an existing activity a less strict proposal (or an extended timescale) may, for example, be acceptable where the activity operates to a standard that is very close to an indicative requirement, but using different plant or processes from that upon which the indicative requirement is based. In such a case it may impose a disproportionate cost to replace the old plant with the new techniques for only a small decrease in emissions.

Specific improvements should be carried out to the timescales agreed with the Regulator and the whole programme of any other items should be completed *at the latest* within three years of the issue of the Permit. Any longer timescales will need to be justified by the Operator in accordance with the principles above.

The applicant should include a proposed timetable covering all improvements.

1.2 Making an application

Complete the separate APPLICATION FORM.

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

The *A1 Guide for Applicants* (see Ref. 6) will help with filling in the form.

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

Departures may be justified as described in Section 1.1.

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

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

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

Assess further options

Justifications may vary from a simple statement to a full cost–benefit analysis *(Note 1)*. **Where the costs and the cross-media benefits of different options need to be assessed, the "Assessment of BAT from Several Options" part of Ref. 7 will help you to do this.**

In SECTION 4, assess the ENVIRONMENTAL IMPACT and confirm acceptability.

Assess that these overall emissions resulting from your view of BAT for the activities or installation will provide a high level of protection for the environment as a whole. The "Assessing Impact of the Installation" part of Ref. 7 will help you to do this.

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

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

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

Note 3 The contents of the outlined BAT boxes in Sections 2, 3 and 4, and additional blank tables, etc., are available electronically on the Environment Agency's web site, for the assistance of applicants.

1.3 Installations covered by this Note

This Note covers installations described in paragraphs (a) to (f), (h) and (i) of Part A (Part A (1) in England and Wales) of Section 2.2 of Schedule 1 to the PPC Regulations (Ref. 2), and also installations described in Section 6.2 Part A (1) paragraph (a) and Section 6.3 Part A paragraph (a) subparagraph (ii). *Note: In Scotland Part A only is used and is a combination of the A1 and A2 processes.*

Non-ferrous metals

2.2 Part A (1)

(a) Unless falling within Part A (2) of this Section, producing non-ferrous metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic activities.

(b) Melting, including making alloys, of non-ferrous metals, including recovered products (refining, foundry casting, etc.) where:

  (i) the plant has a melting capacity of more than 4 tonnes per day for lead or cadmium or 20 tonnes per day for all other metals; and

  (ii) any furnace, bath or other holding vessel used in the plant for the melting has a design holding capacity of 5 tonnes or more.

(c) Refining any non-ferrous metal or alloy, other than the electrolytic refining of copper, except where the activity is related to an activity described in paragraph (a) of Part A (2), or paragraph (a), (d), or (e) of Part B, of this Section.

(d) Producing, melting or recovering by chemicals means or by the use of heat, lead or any lead alloy, if:

  (i) the activity may result in the release into the air of lead; and

  (ii) in the case of lead alloy, the percentage by weight of lead in the alloy in molten form is more than 23 per cent if the alloy contains copper and 2 per cent in other cases.

(e) Recovering any of the following elements if the activity may result in their release into the air: gallium; indium; palladium; tellurium; thallium.

(f) Producing, melting or recovering (whether by chemical means or by electrolysis or by the use of heat) cadmium or mercury or any alloy containing more than 0.05 per cent by weight of either of those metals or, in aggregate, of both.

(h) Manufacturing or repairing involving the use of beryllium or selenium or an alloy containing one or both of those metals if the activity may result in the release into the air of any of the substances listed in paragraph 12 of Part 2 to this Schedule; but an activity does not fall within this paragraph by reason of it involving an alloy that contains beryllium if that alloy in molten form contains less than 0.1 per cent by weight of beryllium and the activity falls within paragraph (a) or (d) of Part B of this Section.

(i) Pelletising, calcining, roasting or sintering any non-ferrous metal ore or any mixture of such ore and other materials.

But this does not cover:

(g) Mining zinc or tin bearing ores where the activity may result in the release into water of cadmium or any compound of cadmium in a concentration which is greater than the background concentration.

Carbon activities

6.2 Part A (1)

(a) Production of carbon or hard burned coal by means of incineration or graphitisation.

Tar and bitumen activities

6.3 Part A (1)

(a) (ii) Heating tar or bitumen for the manufacture of electrodes or carbon based refractory materials, where the carrying out of the activity by the person concerned at the location in question is likely to involve the use in any period of 12 months of 5 tonnes or more of tar or of bitumen or, in aggregate, both.

Interpretation of Part A (1)

In paragraph (g), "background concentration" means any concentration of cadmium or any compound of cadmium which would be present in the release irrespective of any effect the activity may have had on the composition of the release and, without prejudice to the generality of the foregoing, includes such concentration of those substances as is present in:

(i) water supplied to the site where the activity is carried out
(ii) water abstracted for use in the activity
(iii) precipitation onto the site on which the activity is carried out.

Installation boundaries

"Installation" is defined in Part 1 of the Regulations and means:

(i) a stationary technical unit where one or more of the activities listed (above) are carried out; and

(ii) any other location on the same site where any other directly associated activities are carried out which have a technical connection with the activities carried out in the stationary technical unit and which could have an effect on pollution.

They include as appropriate:

- the storage and handling of raw materials
- the storage and handling of fuels
- all smelting, melting and remelting and refining
- holding furnaces
- all transfer operations involving molten metal, whether by launder, ladle or any other means
- handling treatment and storage prior to removal of slags, drosses and other process wastes
- handling treatment and storage of wastes arising from maintenance activities e.g. insulation materials
- finishing activities such as rolling or extrusion where they may have an effect upon emissions and pollution
- waste-water treatment systems.

Holding capacity

When considering the holding capacity of a furnace for the purposes of Part A (1) (b), the following points shall be taken into consideration:

- Where the furnace is to be used to make a range of alloys, then the capacity shall be calculated on the basis of the densest alloy.
- Where it is necessary to retain a molten heel of metal within the furnace after pouring, this retained metal shall be included when calculating the holding capacity.
- The design capacity shall be taken to allow for a reasonable freeboard above the surface of molten material to allow for safe working or pouring.
- Design capacity shall be taken to mean the capacity of the furnace when lined with new refractory.

Production sequences

The main routes whereby non-ferrous metals may be produced from ores or concentrates Part A (1) (a), including Part A (1) (i) where appropriate, are shown in Figure 1.1.

Figure 1.1 Activities involved in the production of non-ferrous metals from ores or concentrates

Mining of ores

Mining only requires an IPPC Permit if subsection (g), which relates to tin or zinc bearing ores, applies and then only where the activity may give rise to a release into water of cadmium or any compound of cadmium in a concentration which is greater than the background concentration. No such mines are currently in operation and mining is not considered further within this Note.

⇓

Preparation of concentrates

In most cases the desired mineral is present in the mined ore at a low concentration. Smelting such low-grade ore is uneconomic and would give rise to large quantities of slag. Concentration processes are used to reduce the proportion of gangue to the point at which smelting is economic.

Processes involved include crushing, screening and flotation, which are normally carried on at the mine, and activities identified in subsection (i), which are normally carried out at the same location as the smelter.

Concentration activities which are not defined in subsection (i) do not require a permit when carried on in isolation, but in view of their very high potential to cause pollution would do so if technically associated with an activity which requires a permit.

⇓

Pre-treatment processes.

Pre-treatment processes such as calcining, roasting or sintering as defined in subsection (i) may be practised in order to alter the chemical or physical form of the concentrate to one most suitable for the smelter, for example by converting sulphides to oxides.

Where a pre-treatment process does not involve a process defined in subsection (i) it will not require a Permit unless it is regarded as a technically associated activity, or is an activity described elsewhere in Schedule 1, e.g. Section 4.2 Part A (j)

⇓

Smelting

The smelting stage involves conversion of a metal compound (frequently an oxide or sulphide, or from secondary sources a silicate) into metal. This may be done by displacing the metal from the compound using a more reactive entity, or by electrolysis.

⇓

Refining

Where thermal smelting techniques are used, the metal produced will contain as impurities a proportion of the other metals present in the concentrate.

The refining techniques which can be used are dictated by the reactivity of the metal, and also its relative reactivity when compared to the impurity.

More reactive metals can be removed by blowing air or oxygen through the melt, thereby oxidising the most reactive components. The unwanted oxide may be removed as a fume with the exhaust gases, as a solid dross or as a slag.

Less reactive metals are normally removed by electrolytic processes.

In some cases separation can be effected by using the physical properties of the metals, such as the use of distillation to separate cadmium and zinc.

⇓

Alloying

Where alloys are manufactured in furnaces which are technically associated with the smelting operation, they form part of the permitted installation.

If the metal is transferred in molten form to the alloying or casting furnaces, then they may be presumed to be technically associated.

Owing to the need to minimise transport costs, concentration activities are normally carried out near the producing mines. Since very little non-ferrous metal ore is mined in the UK, these activities are not normally found here.

For similar reasons, primary smelting is frequently undertaken in mining areas, and few large primary smelting operations are located in the UK. The exceptions are the lead/zinc smelter at Avonmouth, and the aluminium smelters in Wales, the North of England and Scotland.

Transport costs also influence the location of some electrode manufacturing operations, and anodes for use in aluminium smelting are normally manufactured in dedicated plant adjacent to the smelter. In contrast, graphite electrodes are usually manufactured by specialist suppliers of electrodes.

The techniques appropriate to a smelting operation are restricted by the thermodynamics of the system involved, and influenced by the impurities and contaminants which are present in ores and concentrates to be used.

Most secondary non-ferrous metals installations in the UK depend to a greater or lesser extent upon scrap metal as a feedstock. The nature of this scrap, and in particular the nature and extent of contamination by oils, paint, plastics, other types of scrap and any other contaminant will influence the choice of process and the extent to which pollution abatement measures are required.

Figure 1.2 summarises routes whereby non-ferrous metals are recovered from scrap metal and other secondary raw materials.

Figure 1.2 Activities involved in the production of non-ferrous metals from secondary raw materials including melting and associated operations

Pre-treatment
Including removal of organic contaminants (oil, grease, paint and other coatings) by heating in a furnace as defined in Section 2.2 Part B (b) where the activity is associated with an activity defined in Part A (1).

⇩

Smelting or melting
Where defined under subparagraphs (a), (b), (d), (e), (f) or (h).

⇩

Refining
Where defined under subparagraph (c).

⇩

Casting
Where the activity is directly associated with an activity defined in Part 1 A (1).

⇩

Rolling, extrusion and other operations for the manufacture of semi-finished products
In order to satisfy the definition of installation in Regulation 2 of SI 1973, the plant must be on the same site as the melting operation.

In assessing the “technical connection” with the melting plant, consideration should be given to the flow of materials through the different units. Semi-finishing operations shall be considered to be technically linked to the melting operation if a significant proportion of the material rolled, extruded, etc., is first melted and cast in the melting operation.

In assessing “effect on pollution” effects associated primarily with the semi-finishing operation should be included. Particular attention should be paid to noise.

Figure 1.3 summarises the activities involved in manufacturing carbon and graphite electrodes.

Figure 1.3 Manufacture of carbon electrodes

Storage, handling, crushing, grinding and classification of coal, coke or petroleum coke. Hot storage of pitch or bitumen. Used electrodes may be cleaned, crushed and recycled.

⇩

Mixing solids, blending in pitch or bitumen, forming green shaped block.

⇩

Heat in bake furnace and soak at around 1100 °C to carbonise pitch or tar.

⇩

For high conductivity electrodes, heat in electrical resistance furnace to 2800°C and soak in order to convert carbon into graphite. (Anodes for use in pre-bake aluminium furnaces are not graphitised.)

⇩

Graphite electrodes may be machined to shape. All types of electrode may be fitted with metal connectors to aid installation in electrical systems.

Factors to be considered when classifying the production of non-ferrous metals from secondary raw materials

1. Secondary raw materials from which non-ferrous metals are produced are scrap metal, slags, drosses and other residues (such as scrap refractories).

   Metal may be produced from these materials by the following activities:

   - Pre-treatment (such as de-coating) followed by smelting or melting,
   - crushing and screening to remove metallic inclusions from the more friable non-metallic portion, and/or
   - smelting to convert compounds such as oxides and silicates into metal.
2. Smelting is a complex operation and is included within the flow chart of Figure 1.1 whether or not the secondary raw material has been treated to remove metallic inclusions.
3. Where crushing operations for the purpose of removing metallic inclusions from furnace wastes are carried out at the site where they are produced, then they have a clear technical connection with the melting or smelting activity, and in the light of their significance for causing pollution are to be included within the Permit for that installation.
4. Where a crushing operation is the first of a sequence of operations intended to produce metal from wastes, then subsequent melting operations are to be included within the Part A (1) Permit by virtue of the rules for interpretation of a “Part A Installation” in Part 3 of the Regulations.
5. If no metal is recovered from an activity which involves crushing metallurgical slag, and there is no associated Part A activity, then the installation falls under Section 3.5 Part B (a). (A metallurgical slag is a slag generated by a metallurgical activity, whether or not it contains a recoverable or even detectable amount of free metal.)

Drosses, skimmings, fluxes and slags

When metals melt, oxides tend to form and accumulate on the surface. Involatile impurities also float, and these, together with the oxides, can form a dry dusty layer referred to as **dross**.

To reduce the rate of oxidation, and to ease the removal of drosses, **fluxes** may be added which melt on the metal surface. (Fluxes may also be added with the intention of their reacting with impurities within the metal.)

In some operations the dross (with or without added flux) is removed from the molten metal surface by raking or scraping into dross trays beside the furnace door. The material removed may be referred to as dross, or as **skimmings**.

If sufficient flux has been added to combine with the dross to form a liquid layer on the surface of the metal, this layer is referred to as a **slag**. Slag is removed by tapping from the furnace as a fluid.

General issues

The impact of the activities on the environment may be wider than just the on-site activities. This Note and the Regulations cover issues downstream of the installation such as the final disposal of wastes and waste waters.

Advice on the physical site which is contained within the installation, e.g. split sites, is given in IPPC Part A (1) Installations: Guide for Applicants (see Ref. 6). Operators are advised to discuss this issue with the Regulator prior to making their application.

Where associated activities are carried out in conjunction with the main activities and are not covered in this Guidance Note (e.g. a pre-heating furnace may be classified as a combustion plant), reference should be made to:

- other relevant IPPC Guidance Notes,
- relevant Guidance Notes issued under EPA 90, e.g. Refs. 22, 23
- where appropriate, the Secretary of State’s Guidance for Local Authority Air Pollution Control – in Northern Ireland this guidance is produced by the Department of the Environment.

1.3.1 The non-ferrous metals BREF document

The European Commission Reference Document on Best Available Techniques in the Non-Ferrous Metals Industries (the BREF Note, see Ref. 3) covers the production of metals from both primary and secondary raw materials under the chapter headings below:

Chapter 3 – Copper (including Sn and Be) and its alloys
4 – Aluminium
5 – Zinc, lead and cadmium (+ Sb, Bi, In, Ge, Ga, As, Se, Te)
6 – Precious metals
7 – Mercury
8 – Refractory metals
9 – Ferro alloys
10 – Alkali and alkaline earth metals
11 – Nickel and cobalt
12 – Carbon and graphite

Associated foundry and casting operations are covered in a separate BREF Note (Ref. 4). Carbon and graphite production is included because of its close technical association with metals manufacture.

1.3.2 BREF document contents

In the BREF document, information is presented in 13 chapters covering: general information about the industry in Chapter 1, common processes in Chapter 2 and then metallurgical production processes for ten groups of metals in Chapters 3 to 12 as shown above. Chapter 13 presents the conclusions and recommendations. Annexes covering costs and international regulations are also included. The common processes in Chapter 2 are divided as follows:

- Use of the chapter – complex installations.
- Use and reporting of emission data.
- Management, design and training.
- Receipt, storage and handling of raw materials.
- Pre-processing and pre-treatment of raw materials and transfer to production processes.
- Metal production processes – furnace types and process control techniques.
- Gas collection and air abatement techniques.
- Effluent treatment and water re-use.
- Minimisation, recycling and treatment of process residues (including by-products and waste).
- Energy and waste heat recovery.
- Cross-media issues.
- Noise and vibration.
- Odour.
- Safety aspects.
- Decommissioning.
- BAT conclusions for some common processes such as material handling and storage, process control, gas collection and abatement, dioxin removal, sulphur dioxide recovery, mercury abatement and effluent treatment/water re-use.

Each of Chapters 3 to 12 includes sections:

(1) applied processes and techniques,
(2) present emission and consumption levels,
(3) techniques to consider in the determination of BAT, and
(4) BAT conclusions.

These sections give a more detailed description of the processes, including process diagrams in the sections on applied processes.

1.4 Review periods

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

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

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

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

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

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

1.5 Key issues for the sector

Potentially polluting emissions to air

Primary extraction processes which use sulphur containing ores generate substantial quantities of sulphur dioxide.

Most ores and concentrates contain a range of other elements, many of which can have a significant impact on the environment if allowed to escape, for example substances in list I and II of the Hazardous Substances Directive.

Scrap and other secondary raw materials may be contaminated with chlorinated organic compounds such as plastics, lubricants or solvents. These are a potential source of dioxins.

Fugitive emissions to air

Pyro-metallurgical processes subject plant to high temperatures and aggressive atmospheres. In addition the need to move heavy items such as ladles has a potential to cause physical damage to furnaces and ducting. The risk of fugitive emissions into the air is such that it warrants separate consideration as a key issue in any application.

Energy requirements

All pyro-metallurgical processes require significant energy input in order to melt the metal being processed. Primary extraction processes in particular require a high energy input to extract metals from their ores and to purify them.

Accident risk

Particular attention should be paid to the storage and use of liquefied gases such as oxygen, chlorine and LPG (see Section 2.8).

Loss of electrical supplies to control systems and to pollution abatement systems may lead to uncontrolled discharges to air and water.

Flooding, whether caused by rainfall or as a consequence of fire fighting activities, may give rise to uncontrolled emissions to water.

Noise

Many potential sources of noise may be found in non-ferrous metallurgical processes. Particular attention should be paid to:

- movement and storage of scrap;
- location and sound insulation of large fans and air filtration systems;
- rolling mills;
- casting installations, especially billet casters;
- internal transport.

Long-distance and transboundary pollution

For the largest processors an assessment will be required of the potential for long-distance environmental impacts.

Monitoring

Many non-ferrous metals have the potential to release long-term contaminants, such as heavy metals. At each site there should be an assessment of the potential for releases and possible impacts. On the basis of such an assessment, a decision shall be made concerning the need for an environmental monitoring programme (see Section 2.10).

Solid waste recovery, recycling and disposal

The major contribution of the secondary non-ferrous metals industry to recycling metallic wastes is noted; however, the industry itself has significant waste arisings (see Section 2.6). Of particular interest are:

- slags and drosses from melting operations;
- sand from casting operations; and
- insulation and refractory materials from maintenance operations.

Site restoration

Areas for consideration concerning remediation will include:

- storage areas used for slags, drosses and other residues, and
- fuel storage areas.

The majority of non-ferrous metals processes are located on sites which have been used for industrial activities for many years. In many cases, mining, previous waste disposal activities or earlier metallurgical processes will have contaminated the ground. Since such contamination may be confused with potential future contamination arising from activities permitted under IPPC, where past contamination is likely it will be necessary to assess the degree of contamination as a baseline against which future operations can be judged.

Summary

The main issues for the production processes for each of the groups of metals comprise the potential for fugitive emissions and the following components:

- For the production of copper: SO_2, dust, metal compounds, organic compounds, waste water (metal compounds), residues such as furnace linings, sludge, filter dust and slag. Dioxin formation during treatment of secondary copper materials is also an issue.
- For the production of aluminium: fluorides (incl. HF), dust, metal compounds, SO_2, COS, PAH, VOCs, greenhouse gases (PFCs and CO_2), dioxins (secondary), chlorides and HCl. Residues such as bauxite residue, spent pot lining, filter dust and salt slag and waste water (oil and ammonia).
- For the production of lead, zinc and cadmium: dust, metal compounds, VOCs (including dioxins), odours, SO_2, other acid gases, waste water (metal compounds), residues such as sludge, the iron-rich residues, filter dust and slag.
- For the production of precious metals: VOCs, dust, metal compounds, dioxins, odours, NO_x, other acid gases such as chlorine and SO_2. Residues such as sludge, filter dust and slag and waste water (metal compounds and organic compounds).
- For the production of refractory metals, hard metal powder and metal carbides: dust, solid hard metal and metal compounds, waste water (metal compounds), residues such as filter dust, sludge and slag. Process chemicals such as hydrogen fluoride (HF) are used for processing tantalum and niobium and are highly toxic. This needs to be taken into account in the handling and storage of these materials.
- For the production of ferro alloys: dust, metal compounds, CO, CO_2, SO_2, energy recovery, waste water (metal compounds), residues such as filter dust, sludge and slag.

- For the production of alkali and alkaline earth metals: chlorine, HCl, dioxin, SF_6, dust, metal compounds, CO_2, SO_2, waste water (metal compounds), residues such as sludge, aluminate, filter dust and slag.
- For the production of nickel and cobalt: VOCs, CO, dust, metal compounds, odours, SO_2, chlorine and other acid gases, waste water (metal compounds and organic compounds), residues such as sludge, filter dust and slag.
- For the production of carbon and graphite: PAHs, hydrocarbons, dust, odour, SO_2, waste water prevention, residues such as filter dust.

The "Present Emission and Consumption Levels", "Techniques to Consider in the Determination of BAT" and the "BAT Conclusions" contained in all of the chapters of the BREF should be consulted in particular for a more complete understanding of the key issues.

1.6 Summary of releases for each sector

The potential releases to the environment from the various processes are summarised in the following tables.

More details are provided in the BREF in sub section 2 of Chapters 3 to 12.

SOURCE ⇨ / RELEASES ⇩	Raw material storage and handling	Pre-treatment, e.g. sintering or de-coating	Copper process	Aluminium processes	Lead, zinc and cadmium processes	Precious metal processes	Refractory metal processes	Ferro alloy processes	Alkali and alkaline metal processes	Nickel and cobalt processes	Carbon and graphite production	Residue handling, storage and re-use	Air abatement plant	Effluent plant
VOCs		A	A	A	A	A	A	A	A	A	A		A[c]	
Oxides of sulphur		A	A	A	A	A	A	A	A	A	A			
Oxides of nitrogen		A	A	A	A	A	A	A	A	A	A			
Particulates and PM_{10}	A	A	A	A	A	A	A	A	A	A	A	A	A	
Carbon monoxide			A[a]							A				
Mercury	AW	A	A		A									W
Cadmium	W		A		A									W
Other heavy metals	A	A	A	A	A	A	A	A	A	A	A	A	A	W
PFCs				AW										
Hydrogen chloride or fluoride				A		A								
Dioxins and furans		A	A	A	A	A	A	A	A	A	A	A	A	
Ammonia				AW		AW	AW							
Cyanide				W		AW								
Suspended solids	W											W		W
Oil	W											W		W
Stibine/arsine					AW									
Tars and/or PAH				AW							AW			
Sulphides and mercaptans						A								W
Chlorine				A[b]	A	A	A		A					
Metallurgical slags, drosses and furnace residues			L	L	L	L	L	L	L	L				
Dust and dusty residues	L	L										L	L	
KEY	A – release to air, W – release to water, L – release to land													

Notes:

[a] From shaft furnaces designed to operate with a reduced atmosphere in the melting zone.

[b] From certain refining processes.

[c] From afterburners.

NB – releases to air usually result in a subsequent, indirect emission to land and can therefore affect human health, soil and terrestrial ecosystems.

1.7 Overview of the activities in this sector

Estimated number of non-ferrous metals installations in England and Wales which will require permits under Part A (1)

	Primary	Secondary
Copper	0	15
Aluminium	3	35
Zinc, lead, cadmium	1	35[a]
Precious metals	1	10
Alkali and alkali earth metals	2	5
Others	1	10
Totals	**6**	**110[a]**

[a] This total includes an estimate of at least 10 activities with trivial potential for environmental impact as assessed under EPA 90, but which are identified under Part A (1) (d).

The structure of the non-ferrous metals industry within the United Kingdom is steadily changing with the final decades of the 20th century witnessing an increasing dependence upon imports for supplies of metal. Recent developments suggest that this trend will not be reversed.

Secondary smelting and recovery from scrap is also under pressure with the number of installations falling steadily.

The industry, nevertheless, remains an important sector of the economy with its products being essential to the generation and supply of electricity, plumbing and house construction, the aircraft and engineering industry and also the chemical industry.

Although the computing, electronic and telecommunications industries use smaller gross tonnages, their economic significance is high.

A primary factor influencing the above changes is that suitable ore deposits in the United Kingdom have now been largely exhausted, and that transport costs make movement of large tonnages of ores or concentrates less economic.

Recycling is of prime importance in this industry and scrap and other residues are of significant value. The energy requirement for recovering high-grade metals and alloys from scrap is much lower than for manufacturing similar alloys from ores or concentrates.

The industry is a major consumer of energy, with the potential for significant releases to land and to air.

1.7.1 Processes used in the manufacture of non-ferrous metals

Primary processes

- concentration and purification of ores
- conversion of ores into forms suitable for smelting, e.g. sulphide ores to oxides
- smelting
- refining
- alloying

Secondary processes

- scrap pre-treatment
- smelting, Melting and refining
- alloying

(a) Smelting processes

- **Fused salt electrolysis** – Strongly electropositive metals such as the alkali and alkali earth metals can only be manufactured by electrolysis of fused salts, usually chlorides. The metals themselves are intensely reactive when molten, as is the by-product chlorine gas. The design of the cells must ensure that molten metal does not come into contact with air, and that all chlorine is removed and liquefied for sale.
- **Electrolysis of oxides dissolved in fused salts** – Aluminium cannot be smelted by heating its oxide with carbon, but instead is manufactured by electrolysis of its oxide when dissolved in molten fused fluorides approximating to the composition of natural cryolite.

  The oxygen produced as a by-product consumes the carbon anode to generate carbon monoxide, which in turn burns off at the surface of the electrolyte. This continuous flow of gas through the hot electrolyte generates an emission of volatile fluorides. This is accompanied by sulphur compounds and other decomposition products from the anodes. The regular disposal of old cell structures known as spent pot lining can have a major environmental impact.
- **Displacement reactions** – The most widely used process involves heating an oxide of the metal with carbon to yield carbon monoxide and metal. This process forms the basis for primary smelting of zinc, lead and tin.

  Hydrogen or a reactive metal, e.g. aluminium used to smelt chromium, may also be used.

  Air pollution problems are potentially highly significant for larger installations as also may be waste disposal issues arising from slag generation.

(b) Smelting and melting

For secondary raw materials smelting and melting are often carried together in the following stages.

- **Fossil fuel fired furnaces** – These include rotary furnaces and static bath furnaces.

  Rotary furnaces are difficult to seal and consequently fugitive emissions to air are hard to eliminate completely. They are, however, very efficient at mixing metal and flux, and are thus the favoured furnace for handling low grades of scrap.

  Static bath furnaces can be designed to handle larger items of scrap, and are capable of being sealed more effectively than rotary furnaces.

  For all fossil fuel fired furnaces, gas is the preferred fuel as it does not carry any risk of ground contamination due to spillage, and is also easier to burn efficiently.

  Oxygen enrichment and oxyfuel burners should also be considered as the volume of the products of combustion is markedly reduced by the elimination of nitrogen. The benefit in terms of cost and fuel efficiency is off set to a degree by the costs arising from oxygen manufacture, but significant environmental benefit can arise as a consequence of the much smaller volumes of exhaust gas.
- **Pre-treatment and cleaning operations for scrap, drosses, slags and other residues** – Drosses, slags and other furnace residues are normally prepared for recycling by first crushing or milling to free the metallic inclusions, then screening. The metal content concentrates in the large fraction.

  These activities may be carried on as part of a waste minimisation activity at the furnace, as a pre-treatment, or as a stand-alone, independent operation.

  In all cases, the potential for dust emissions is high. In some cases, e.g. aluminium drosses, there is a significant potential for odour, and for water pollution should drosses become wet – whilst in a few, e.g. zinc drosses, the gases given off by wet dross are hazardous to health.

  Minimising the non-metallic content of the furnace charge reduces the amount of solid waste generated, and also the specific energy consumption.
- **Scrap metal from cutting, milling and similar operations** – These form a valuable feed for secondary smelters, particularly where proper segregation is practised at source, and cross-contamination with other swarf avoided (see Ref. 9 – Environmental Technology Best Practice Guide GG264).

  They are, nevertheless, likely to be contaminated with cutting oils and require cleaning before being charged into a melting furnace.

The extent to which cleaning is required will depend upon the design of the melting furnace, some of which can include combustion systems designed to cope with oily charges. In most cases, it will be necessary to remove most of the oil by:

- draining in designated de-oiling areas;
- centrifuging;
- heating to drive off volatile components, followed by destruction of VOCs in an after-burner.

These techniques may be used separately, or in combination, but whichever de-oiling system is used, it must be considered in combination with the furnace with which it is associated.

At present, chlorinated cutting oils remain in widespread use within the United Kingdom. Consequently, furnaces which handle oil swarf must be regarded as potential sources of dioxins.

- **Scrap metal from extrusion and rolling operations** – These will be contaminated to a greater or lesser extent by soaps and lubricants used in the forming operations. This contamination can be significant in certain cases such as tube ends from cold drawing benches.

  The physical nature of the waste makes pre-cleaning more difficult, and greater emphasis must be placed upon the design and operation of melting furnaces.

- **Recovered scrap –** This comes from a wide variety of sources. Some, such as motor vehicle engine and transmission parts, may be so grossly contaminated that washing represents a practicable means of pre-treatment.

  Where recovered scrap is to be processed, careful attention should be paid to those aspects of the EMS which ensure that only material that is compatible with the furnace is sent forward for melting.

(c) Melting processes

Melting processes for clean metal such as ingots or very clean scrap can use the furnaces described above but the most frequently encountered is the following.

- **Electric induction furnaces –** These are widely used to melt metal, with feedstock ranging from pure ingot to scrap and this includes iron components recovered in a rodding plant of a primary aluminium smelter. They have the advantage of being relatively simple to enclose, thus minimising fugitive emissions to air. They can also be designed for complete enclosure, permitting the use of controlled atmospheres above the melt.

  By virtue of the presence of electrical conductors in their construction, they are more vulnerable to corrosion and erosion by slags than directly fired furnaces, and are most suitable for making products from clean raw materials.

The following tables are derived from the Non-Ferrous Metals BREF Note.

Drying, roasting, sintering and calcining furnaces

Furnace	Metals used	Material used	Comment
Steam coil dryer Fluid bed dryer Flash dryer	Cu and some others	Concentrates	Drying operations
Rotary kiln	Most metals for drying; fuming ZnO; calcining alumina, Ni and ferro alloys; burning of photographic film for precious metal production; de-oiling Cu and Al scrap	Ores, concentrates and various scrap and residues	Drying, calcining and fuming applications
Fluidised bed	Copper and zinc; Al_2O_3	Concentrates, $Al(OH)_3$	Calcining and roasting
Up draught sintering machine	Zinc and lead	Concentrates and secondary	Sintering
Down draft sintering machine	Zinc and lead	Concentrates and secondary	Sintering
Steel belt sintering machine	Ferro alloys, Mn, Nb	Ore	Other applications possible
Herreshoff	Mercury, molybdenum (rhenium recovery)	Ores and concentrates	Roasting, calcining

Smelting and refining furnaces

Furnace	Metals used	Material used	Comment
Enclosed refractory lined crucibles	Refractory metals, special ferro alloys	Metal oxides	
Open pit	Refractory metals, special ferro alloys	Metal oxides	
Baiyin	Copper	Concentrates	
Electric arc furnace	Ferro alloys	Concentrates, ore	
Contop/cyclone	Copper	Concentrates	
Submerged electric arc furnace	Precious metals, copper, ferro alloys	Slag, secondary materials, concentrates	For the production of ferro alloys, the open, semi-closed and closed types are used
Rotary	Aluminium, lead, copper, precious metals	Scrap and other secondary, blister copper	Oxidation and reaction with substrate
Tilting rotary furnace	Aluminium	Scrap and other secondary	Minimises salt flux use; may have restrictions on size of material
Reverberatory	Aluminium, copper, others	Scrap and other secondary, black copper	Smelting of Cu concentrates elsewhere in the World
Vanyucov	Copper	Concentrates	
ISA smelt/ausmelt	Copper, lead	Intermediates, concentrates and secondary materials	
QSL	Lead	Concentrates and secondary	
Kivcet	Lead, copper	Concentrates and secondary	
Noranda	Copper	Concentrates	
El Teniente	Copper	Concentrates	
TBRC TROF	Copper (TBRC), precious metals	Most secondary incl. slimes	
Mini smelter	Copper/lead/tin	Scrap	
Blast furnace and ISF	Lead, lead/zinc, copper, precious metals, high carbon ferro-manganese	Concentrates, most secondary	For ferro-manganese production, it is only used together with energy recovery
Inco flash furnace	Copper, nickel	Concentrates	
Outokumpu flash smelter	Copper, nickel	Concentrates	
Mitsubishi process	Copper	Concentrates and anode scrap	
Peirce Smith	Copper (converter), ferro alloys, metal oxide production	Matte and anode scrap	
Hoboken	Copper (converter)	Matte and anode scrap	
Outokumpu flash converter	Copper (converter)	Matte	
Noranda converter	Copper (converter)	Matte	
Mitsubishi converter	Copper (converter)	Matte	

Melting furnaces

Furnace	Metals used	Material used	Comment
Induction	Most	Clean metal and scrap	Induced stirring assists alloying; vacuum can be applied for some metals
Electron beam	Refractory metals	Clean metal and scrap	
Rotary	Aluminium, lead	Various scrap grades	Fluxes and salts used for complex matrices
Reverberatory	Aluminium (primary and secondary)	Various scrap grades	Bath or hearth configuration can vary; melting or holding
Contimelt	Copper	Copper anode, clean scrap and blister copper	Integrated furnace system
Shaft	Copper	Copper cathode and clean scrap	Reducing conditions
Drum (Thomas)	Copper	Copper scrap	Melting, fire refining
Heated crucibles (indirect kettles)	Lead, zinc	Clean scrap	Melting, refining, alloying
Direct heated crucibles	Precious metals	Clean metal	Melting, alloying

Hydrometallurgical processes are also used. Acids and alkalis (NaOH, sometimes also Na_2CO_3) are used to dissolve the metal content of a variety of calcines, ores and concentrates before refining and electro-winning. The material to be leached is usually in the form of the oxide, either as an oxidic ore or as an oxide produced by roasting. Direct leaching of some concentrates or mattes is also performed at both elevated and atmospheric pressure. Some copper sulphide ores can be leached with sulphuric acid or other media, sometimes using natural bacteria to promote oxidation and dissolution, but very long residence times are used.

Air, oxygen, chlorine or solutions containing ferric chloride can be added to leaching systems to provide the appropriate conditions for dissolution. The solutions that are produced are treated in a number of ways to refine and win the metals. Common practice is to return the depleted solutions to the leaching stage, where appropriate, to conserve acids and alkaline solutions. Nitric acid and other reactive reagents are used to recover precious metals.

Overview of chemical treatment methods for some gaseous components

Process/reagent used	Component in off-gas	Treatment method
Use of arsenic or antimony oxide (refining of Zn/Pb)	Arsine/stibine	Permanganate scrubbing
Pitch etc.	Tars and PAH	After burner, condenser and EP or dry absorber
Solvents, VOCs	VOC, odour	Containment, condensation; activated carbon, bio-filter
Sulphuric acid (+ sulphur in fuel or raw material)	Sulphur dioxide	Wet or semi-dry scrubber system; sulphuric acid plant
Aqua regia	NOCl, NO_x	Caustic scrubber system
Chlorine, HCl	Cl_2	Caustic scrubber system
Nitric acid	NO_x	Oxidise and absorb, recycle, scrubber system
Na or KCN	HCN	Oxidise with hydrogen peroxide or hypochlorite
Ammonia	NH_3	Recovery, scrubber system
Ammonium chloride	Aerosol	Recovery by sublimation, scrubber system
Hydrazine	N_2H_4 (possible carcinogen)	Scrubber or activated carbon
Sodium borohydride	Hydrogen (explosion hazard)	Avoid if possible in PGM processing (especially Os, Ru)
Formic acid	Formaldehyde	Caustic scrubber system
Sodium chlorate/HCl	Cl oxides (explosion hazard)	Control of process end-point

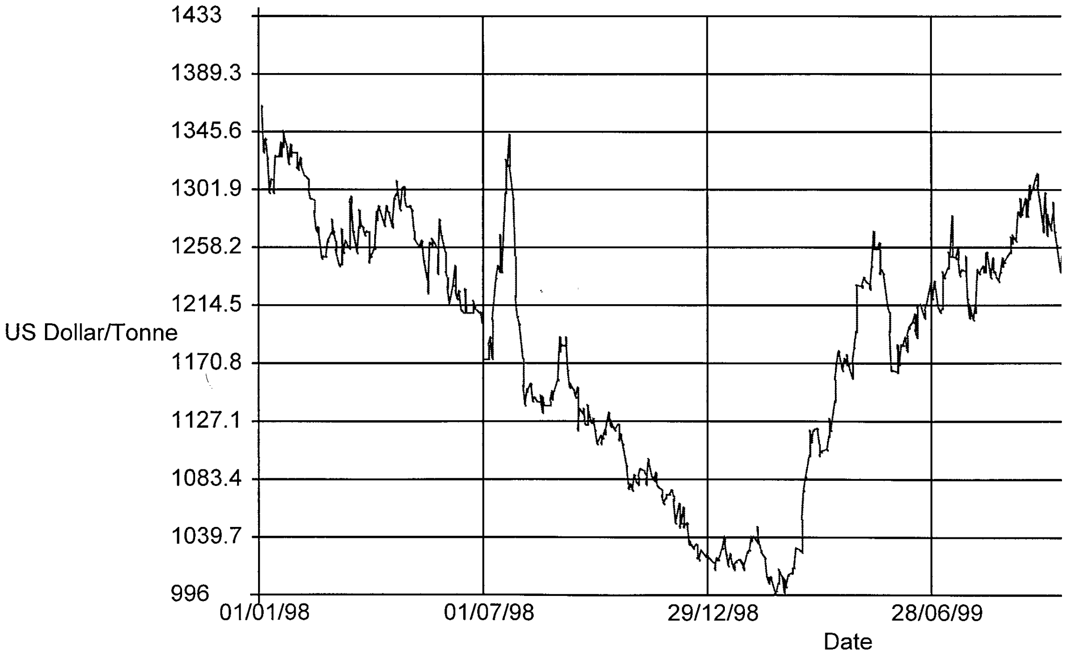
Process descriptions and diagrams are given in the BREF in subsections 1 and 2 of each the Chapters 3 to 12.

1.8 Economic aspects for each sector

Most non-ferrous metals are international commodities, with prices more heavily influenced by supply and demand than by the cost of production. The major metals (aluminium, copper, lead, nickel, tin and zinc) are traded on one of two futures markets, the London Metal Exchange and Comex in New York. The collectively named "minor" metals have no central market-place; price levels are imposed by either producers or merchants trading in the free markets. In most applications non-ferrous metals are in competition with other materials, notably ceramics, plastics and other ferrous and non-ferrous metals. The influence upon world prices is illustrated in Figure 1.4, which shows the variation in price of aluminium alloy between January 1998 and December 1999, the information being published the by London Metal Exchange. During this period the variation in production costs was not significant.

The profitability of each metal or metals group, and thus the economic viability of the industry, varies, both absolutely and on a short-term basis, depending upon the current metal price and a wide range of other economic factors. The general economic rule applies however, i.e. that the nearer a material or product approaches global market conditions and international commodity status, the lower is the return on the capital invested.

Figure 1.4 Aluminium alloy price variation



Annex 1 of the BREF provides some specific cost data for plant and abatement equipment used in this sector.

It is effective to consider normal investment and expenditure cycles when improvement programmes are being planned. Many win–win solutions are reported in the Non-Ferrous Metals BREF in the sections dedicated to "Techniques to Consider in the Determination of BAT" and these techniques can reduce environmental impact and increase metal yield and efficiency.

2 TECHNIQUES FOR POLLUTION CONTROL

BAT boxes to help in preparing applications

This section summarises, in the outlined BAT boxes,

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

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

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

Indicative BAT requirements

Where it has been possible for the Regulator to make a judgement on what will normally be BAT, the indicative requirements are clear and prescriptive. In such cases:

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

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

Justifying proposals

Whether you are

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

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

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

Prevention is the priority

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

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

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

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

2.1 Management techniques

Within IPPC, an effective system of management is a key technique for ensuring that all appropriate pollution prevention and control techniques are delivered reliably and on an integrated basis. The Regulators strongly support the operation of environmental management systems (EMSs). An Operator with such a system will find it easier to complete not only this section but also the technical/regulatory requirements in the following sections.

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

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

BAT for management techniques

BREF Section 2.3

Application Form Question 2.1

Provide details of your proposed management techniques.

With the application the Operator should:

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

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

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

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

Indicative BAT requirements

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

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

Cont.

BAT for management techniques (cont.)

BREF Chapter 2.17.2

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

Cont.

BAT for management techniques (cont.)

14. **Corrective action to analyse faults and prevent recurrence** Define responsibility and authority for handling and investigating non-conformance, taking action to mitigate any impacts caused and for initiating and completing corrective and preventive action. Recording, investigating, taking corrective action and preventing recurrence, in response to environmental complaints and incidents	Describe in this Section how this is dealt with for each of Sections 2.2 to 2.3 and 2.5 to 2.10 as appropriate
15. **Reviewing and reporting environmental performance** Senior management review environmental performance and ensure appropriate action taken where necessary to ensure that policy commitments are met and that policy remains relevant. Review progress of the management programmes at least annually. Incorporate environmental issues in all other relevant aspects of the business, insofar as they are required by IPPC, in particular: • the control of process change on the installation; • design and review of new facilities, engineering and other capital projects; • capital approval; • the allocation of resources; • planning and scheduling; • incorporation of environmental aspects into normal operating procedures; • purchasing policy; • accounting for environmental costs against the process involved rather than as overheads. Report on environmental performance, based on the results of management reviews (annual or linked to the audit cycle), for: • information required by the Regulator; and • effectiveness of the management system against objectives and targets, and future planned improvements. Report externally, preferably via public environmental statement	Describe in this Section Describe in this Section This will become a Permit requirement Describe in this Section Describe in this Section
16. **Managing documentation and records** List the core elements of the EMS (policies, responsibilities, procedures, etc.) and links to related documentation in order to be able to control, locate and update documentation. Describe how environmental records and results of audits and reviews are identified, maintained and stored	Describe in this Section

Selection of raw materials

2.2 Materials inputs

This section covers the use of **raw materials and water** and the techniques for both minimising their use and minimising their impact by selection. Depending upon furnace design, pre-treatment of raw materials may be required before melting.

As a general principle, the Operator should demonstrate the steps which have been, or may be, taken to:

Reduce
Substitute
Understand

- **reduce** the amount of flux required by improving the quality of raw materials;
- **substitute** less harmful materials or those which can be more readily abated and when abated lead to substances which in themselves are more readily dealt with;
- **understand** the fate of by-products and contaminants and their environmental impact (Section 4).

2.2.1 Raw materials selection and pre-treatment

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

Application Form Question 2.2 (part 1)

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

BAT for selection of raw materials

BREF Sections: 2.4 and 2.5

With the application the Operator should:

1. Supply a list of the materials used, which have the potential for significant environmental impact, including:
   - the chemical composition of the materials where relevant;
   - the quantities used;
   - the fate of the material (i.e. approximate percentages to each media and to the product);
   - environmental impact where known (e.g. degradability, bioaccumulation potential, toxicity to relevant species);
   - any reasonably practicable alternative raw materials which may have a lower environmental impact (the substitution principle).

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

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

2. Justify the continued use of any raw material for which there is a less harmful alternative, and that the raw material selection is therefore BAT. Justification may be based on effect upon product quality; security of supply; use of a material which would otherwise be disposed of as a waste; lower energy consumption. Economic factors may also be considered.

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

Indicative BAT requirements

BAT for selection

1. Improvement conditions should be agreed within a timescale approved by the Regulator;
   - complete any longer-term studies (item 3 above),
   - carry out any substitutions identified,

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

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

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

Use of raw materials

2.2.2 Waste minimisation (minimising the use of raw materials)

Principles

The prevention and minimisation of waste and emissions to the environment is a general principle of IPPC. Operators will be expected to consider the application of waste minimisation techniques so that, wherever practicable, all types of wastes and emissions are prevented or reduced to a minimum. The steps below will also help to ensure the prudent use of natural resources.

Waste minimisation can be defined simply as:

BREF Chapter 2.6.8

"a systematic approach to the reduction of waste at source, by understanding and changing processes and activities to prevent and reduce waste".

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

In applying this general principle it is necessary to bear in mind that many non-ferrous metals operations are waste recovery systems in their own right. Therefore in the context of waste minimisation and this Guidance, **waste** relates to the inefficient use of raw materials and other substances at an installation; replacing dross millings with virgin metal will reduce the amount of waste produced by the installation, but at an overall environmental cost. A consequence of waste minimisation will be the reduction of gaseous, liquid and solid emissions.

Key operational features of waste minimisation will be:

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

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

References (see Ref. 9) provide detailed information, guides and case studies on waste minimisation techniques. Existing sector guidance should cover cleaner technologies and waste minimisation opportunities specific to the relevant sector.

Application Form Question 2.2 (part 2)

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

BAT for minimisation

BREF Section 2.10

Emission and consumption data are given in subsection 2 of Chapters 3 to 12

With the application the Operator should:

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

Indicative BAT requirements

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

   The Operator should analyse the use of raw materials, assess the opportunities for reductions and provide an action plan for improvements using the following three essential steps:
   (i) process mapping;
   (ii) raw materials mass balance;
   (iii) action plan.

   The use and fate of all raw materials should be mapped onto a process flow diagram (see Ref. 9) using data from the raw materials inventory (see Section 2.2.1) and other relevant data. Particular attention should be paid to impurities in raw materials which will be concentrated within particular waste streams. Pollutants (e.g. dioxins) which will be created by the activity should also be identified. Data should be incorporated for each principal stage of the operation in order to construct a mass balance for the installation.

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

Water use

2.2.3 Water use

The most frequent use of water is as a coolant, though some processes use water in gas scrubbing systems.

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

Reasons for reducing water use

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

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

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

In addition to the BREF, advice on cost-effective measures for minimising water can be found in Envirowise publications (see Ref. 10).

Application Form Question 2.2 (part 3)

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

With the application the Operator should:

BAT for water efficiency

BREF Section 2.9

Emission and consumption data are given in subsection 2 of Chapters 3 to 12

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

Indicative BAT requirements

BAT for water efficiency

1. A regular review of water use (water efficiency audit) should be carried out. Where one has not been carried out recently, an initial comprehensive audit should be carried out at the earliest opportunity within the improvement programme. New plants will need to have been operating for some time before an audit will be meaningful. Further audits should be at least as frequent as the IPPC Permit reviews. The audit should be carried out as follows:
   - The Operator should produce flow diagrams and water mass balances for the activities.
   - Water efficiency objectives should be established by comparison with sector guidance or, where not available, national benchmarks (see Ref. 11). In justifying any departures from these (see Section 1.2), or where benchmarks are not available, the techniques described below and those in the existing sector guidance should be taken into account. The constraints on reducing water use beyond a certain level should be identified by each Operator, as this is usually installation-specific.
   - Water pinch techniques should be used in the more complex situations, particularly where wet scrubbing systems are in use, to identify the opportunities for maximising re-use and minimising use of water (see ENVIROWISE publications, Ref. 10).
   - Using this information, opportunities for reduction in water use should be generated and assessed and an action plan prepared for the implementation of improvements to a timescale approved by the Regulator.

Cont.

Water use

BAT for water efficiency (cont.)

2. The following general principles should be applied in sequence to reduce emissions to water:
   - Closed circuit cooling systems should be used where possible.
   - Water should be recycled within the process from which it issues, by treating it first if necessary. Where this is not practicable, it should be recycled to another part of the process which has a lower water quality requirement.
   - Drainage systems should be designed to avoid contamination of roof and surface water. Where possible this should be retained for use. That which cannot be used should be discharged separately.

3. Measures should be implemented to minimise contamination risk of process or surface water (see Section 2.3.13).

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

5. Ultimately waste water will need some form of treatment (see Section 3). However in many applications, the best conventional effluent treatment produces a good water quality which may be usable in the process directly or when mixed with fresh water. While treated effluent quality can vary, it can be recycled selectively, when the quality is adequate, reverting to discharge when the quality falls below that which the system can tolerate. The Operator should identify where treated water from the effluent treatment plant could be used and justify where it is not.

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

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

2.3 The main activities and abatement

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

Application Form Question 2.3

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

BAT for the main activities

BREF Sections 3.1, 4.1, 5.1, 6.1, 7.1, 8.1, 9.1, 10.1, 11.1, 12.1 describe the applied techniques and give process descriptions

With the application the Operator should:

1. Provide adequate **process descriptions** of the activities and the abatement and control equipment for all of the activities such that the Regulator can understand the process in sufficient detail to assess the Operator's proposals and, in particular, to assess opportunities for further improvements. This should include:
   - process flow sheet diagrams (schematics);
   - piping and instrumentation diagrams for systems containing potentially polluting substances;
   - diagrams of the main plant items where they have environmental relevance, e.g. furnace layout, extraction systems, fan capacities, abatement plant, chimney heights;
   - details of any chemical reactions and their reaction kinetics/energy balance;
   - control system philosophy and how the control system incorporates environmental monitoring information;
   - failure warning devices for abatement plant;
   - annual production, mass and energy balance information;
   - venting and emergency relief provisions;
   - summary of extant operating and maintenance procedures;
   - a description of how protection is provided during abnormal operating conditions such as start-up, shut-down and momentary stoppages.

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

2. Describe the current or proposed position for all of the requirements listed below, for any additional requirements listed in subsections 2.3.1 to 2.3.14, and for any others pertinent to the installation.

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

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

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

Indicative BAT requirements

BREF Sections 3.4, 4.4, 5.4, 6.4, 7.4, 8.4, 9.4, 10.4, 11.4 and 12.4

The following techniques should be applied where appropriate to all installations. Further requirements are identified or specific requirements emphasised in the process-specific subsections below.

1. Matching of the design against proposed raw materials and products. Features to which particular attention should be paid are:
   - Fuel selection and burner design.
   - Minimising the number and frequency of transfers of hot metal.
   - Matching air extraction and filtration systems to requirements.
   - Constraints on purchasing policy and raw material selection.

Cont.

- Where exhaust volumes are large, avoid the use of after-burners as a means of controlling emissions of carbon monoxide, VOCs and dioxins. Preferred alternatives include:
  - only processing material free from oil, grease plastic or paint;
  - installing pre-treatment systems such as washers, centrifuges or swarf dryers to remove organic contamination.
- In assessing proposals which may involve the use of after-burning, the quantity of carbon dioxide generated should be balanced against the quantity of VOC destroyed. Each cubic metre of exhaust gas passed through an after-burner could generate some 30 gm of carbon dioxide.
- Provision of dry storage facilities for those raw materials and solid wastes which may react with or contaminate water.
- Provisions for handling and storage of dusty materials including dust removed from air filters.
- Bunding for tanks and pipes containing fuels and other fluids. Use above-ground fuel lines and pipelines so that leaks can be detected quickly and repaired.
- Design of hydraulic systems so as prevent contamination of furnace charges with hydraulic oils in the event of leakage.
- Emergency power supplies for safety and environmentally critical plant.

2. Minimising the impact upon water consumption and pollution by:
   - Design, control and operation of storage and process areas so as to avoid contamination of storm water.
   - Design of the storm water drainage system so as to minimise the risk of contamination.
   - Use of a closed cycle system for cooling.

3. Minimise waste generation by:
   - Optimising the ratios of slag to metal used in melting operations.
   - Where possible, re-using slags.
   - Recovering re-usable materials from slags.

4. Avoiding the risk of creating secondary pollution by:
   - Using biodegradable hydraulic oils in any location where failure could lead to water contamination.
   - Not using chlorinated cutting oils on any activity that gives rise to scrap which could be recharged into a melting furnace.
   - Avoiding charging scrap contaminated with chlorinated cutting oils into melting furnaces.
   - Avoid using chlorinated solvents for degreasing metal.

5. Minimising the potential for noise nuisance, in particular from:
   - Elevated machinery such as conveyors or skip hoists.
   - Mechanical handling, such as discharge from billet casters
   - Vehicle movement, especially internal load carriers such as fork lift trucks.

6. Ensuring proper operation by:
   - Operation of an effective environmental management system.
   - Minimising the impacts of accidents and failures through an emergency plan.

7. Further requirements of relevance to specific activities are identified within each subsection below.

Copper & copper alloys

2.3.1 Copper and copper alloys

2.3.1.1 Smelting

BREF Sections 3, 3.1.1, 3.1.2

Process: There are no copper smelters in operation in the United Kingdom, and there is no likelihood of one being constructed within the foreseeable future. Smelting is not considered further in this Note.

2.3.1.2 Wire, rod and tube production

BREF Section 3.1.4

SI 1973 2.2 A (1) (b)(ii) or A (2) (a)

Process: High-purity electrically refined copper is melted in a gas fired shaft furnace under reducing conditions. For tube production the metal is further deoxidised by adding phosphor copper in a holding furnace, then cast in a continuous casting machine.

The continuously produced billet is cut to length by a saw, then passed on to the extrusion plant where it is reheated before being extruded then drawn to make wire or tube.

Various annealing and surface treatment operations may be incorporated into the extrusion/drawing plant.

Scrap from extrusion/drawing operations may be recycled to the shaft furnace, as are millings from the cast shop saw.

Water: Water is not used in the process other than as a coolant. There is a limited potential for water contamination arising from spillage of lubricants or de-greasing fluids.

Land: There is minimal production of solid waste. There is a potential for ground contamination from spillage of lubricants and de-greasing fluids.

Air: Melting must be done under reducing conditions in order to minimise the amount of oxygen absorbed in the molten metal and in the case of rod to protect the refractory. With natural gas as a fuel this can be achieved by operating the burners fuel-rich to achieve a carbon monoxide (CO) concentration of under 1% in the products of combustion at the burners. The counter-current flow whereby hot gases rising up the shaft give up their heat to descending solid copper means that any oils or grease on the copper are distilled out, giving a VOC release. Carbon monoxide and VOCs could be greatly reduced by after-burning, but at the cost of a significant reduction in energy efficiency.

Extrusion and drawing require pre-heating furnaces which will give rise to modest releases of products of combustion. After processing, lubricants will need to be removed from the product. This cleaning operation has a potential for VOC and particulate release from cleaning operations.

Energy: Owing to the counter current flow of gases and metal in the shaft furnace, energy losses in the form of hot exhaust gases are minimised.

Noise: The melting process involves handling large amounts of copper cathode with ample opportunity for random noise if handled carelessly. Saws and product handling are also potential sources of noise. The gas burners and shaft can generate resonance noise.

Accidents: The environmental potential of accidents is not great, although the possibility of ground contamination being caused by spilling cleansing fluids should not be overlooked.

Application Form Question 2.3 (cont.) → Copper wire, rod and tube production

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 28 for this aspect of the activities.

Indicative BAT requirements

BAT for copper wire, rod and tube production

BREF Section 3.1.4.1

- Carbon monoxide generation to be minimised by sequential monitoring of combustion conditions and independent automatic control of fuel/air ratios at the burners.
- Charge handling systems designed to avoid the possibility of contaminating feedstock with hydraulic oils or lubricants.
- Purchasing and inspection procedures to prevent charging of material contaminated with drawing or extrusion lubricants.

Copper & copper alloys

2.3.1.3 Melting copper, melting and making copper alloys

Summary of the activities

BREF Section 3.1.5.1

Section 2.2 part A (1) (b) or (c), or Part A (2). Also, if directly associated with such a melting activity, Part B (b)

Process: Copper can be alloyed with zinc, tin, nickel, aluminium, lead and other elements to make a wide range of alloys. The most frequently encountered are brass (copper and zinc), bronze (copper and tin), cupro-nickel, aluminium bronze and gun metal (copper with tin or zinc).

In some alloys, notably brasses, lead is added in order to improve machinability. Less frequently alloys which incorporate cadmium (overhead conductor wire) and beryllium (electrical contacts and fine castings) will be encountered.

The design of the furnace, its pollution abatement systems and the manner in which it is operated must be adapted to the raw materials used and the intended product. Where volatile metals, such as zinc, are present the furnace must be well hooded to permit the removal of fume to a suitable filtration plant. The hooding and enclosure system must be capable of containing fume during charging and casting, as well as during melting and any associated refining.

In the case of raw materials that are not pre-treated and are contaminated with organic materials, they shall only be processed in furnaces fitted with suitable after-burners to destroy smoke and VOCs generated by decomposition.

A variety of furnaces can be used, depending upon the source of raw material and product.

Induction furnaces are suitable where the desired alloy composition can be achieved without recourse to significant refining.

Where it is necessary to lance below the melt, or where significant quantities of slag may be generated, then a gas-fired rotary or reverberatory furnace may be more appropriate.

In all furnaces, fume generation is to be minimised by effective furnace control, though only for copper or cupro-nickel alloys is this alone likely to give sufficient abatement to be considered BAT.

BREF Section 2.5.1.9

BREF Table 3.3.7, Section 3.4.3

Machining wastes such as swarf, millings and turnings are likely to be contaminated with cutting oils. If the melting furnace is not designed to prevent the emission of smoke, or is not fitted with an after-burner, then the oils must be removed from such wastes before they are charged to the furnace. This may be achieved by washing, by the use of centrifuges or after-burners or a combination of such techniques.

A typical swarf dryer consists of an indirectly heated drum where the swarf is heated to approximately 400°C to drive off volatile fluids. The exhaust gas from this drum is then passed through an after-burner at 850°C to destroy the VOCs before discharge into the air.

If fine millings are being processed, or if alloys containing lead are being handled, then it will be necessary to cool and filter the exhaust gases before discharge.

If material contaminated with chlorinated cutting oils is to be charged to a furnace or swarf dryer, then that furnace or dryer shall be fitted with an abatement plant capable of reducing the concentration of dioxins in the emission to 0.1ng/m^3.

Water: Water is used as a coolant and some casting tracks will generate a quantity of water contaminated with oil. Where oily swarf is to be used, storage and handling must be designed to prevent cutting oils draining off and contaminating water discharges.

Waste: Furnace operations will give rise to varying amounts of slags and drosses. Solid wastes will also arise when furnaces are rebuilt. Filtration systems will also generate significant quantities of dust.

Air: Fugitive releases, in particular those arising from operations involving transfer of molten metal, will require careful attention. Contained emissions to air will normally require filtration to remove metal oxides. Where highly toxic materials such as cadmium are present, dual filtration is necessary. After-burning may be necessary to minimise releases of VOCs.

Energy: Energy requirements are significantly influenced by the need to minimise air pollution. In particular, after-burners and large extraction and filtration systems require significant energy input.

Copper & copper alloys

Noise: All foundry operations involve moving lumps of metal around. Charging and casting machines are particularly prone to cause annoyance. Sound insulation around cleaning mechanisms and fans on large filtration plants need to be well designed, and properly maintained.

Accidents: Fires in air filtration systems. This can cause significant air pollution whilst the fire is being bought under control.

Application Form Question 2.3 (cont.) — Melting copper, melting and making copper alloys

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

BAT for melting copper, melting and making copper alloys

Indicative BAT requirements

1. Particular attention should be paid to procedures designed to ensure that unwanted materials such as alloys containing cadmium are not accidentally included in furnace charges.
2. The dust removal system shall be designed and operated so as to minimise the quantity of dust held inside the filter chamber, so as to minimise the risk of fires.
3. The environmental impact assessment shall provide information on the potential impact of releases which may arise as a consequence of a fire in extraction ducts, filters or the oxide area. This assessment shall include consideration of emissions from the furnace during any emergency shut-down of the filter plant.

Aluminium & aluminium alloys

2.3.2 Aluminium and aluminium alloys

2.3.2.1 Primary smelting (excluding carbon anode manufacture which is covered in Section 2.3.9)

BREF Section 4.1.1

SI 1973 Section 2.2 Part A (1) (a)

BREF Section 4.1.1.1

Process: The first stage in producing aluminium from bauxite is to manufacture aluminium oxide (alumina) by the Bayer process.

The sole installation which operates this process in the United Kingdom has no connection with manufacture of aluminium metal. UK smelters are likely to rely upon imported alumina for the foreseeable future. It is unlikely that additional work will be undertaken to include this process in a Chemicals BREF and the Non-Ferrous Metals BREF will be the only source of data.

SI 1973 Section 4.2 Part A (1) (a) (v)

(a) Production of aluminium by electrolysis

BREF Section 4.1.1.2

Process: Aluminium metal is produced by the electrolytic reduction of alumina dissolved in a bath which mainly consists of molten cryolite (sodium aluminium fluoride) at a temperature of approximately 960°C.

Most smelters operate with aluminium fluoride present in excess of the stoichiometric ratio for cryolite. Many also add fluorides of magnesium, calcium or lithium to the melt. These additions are made with the intention of improving conductivity and reducing both density and melting point of the melt.

The furnace body, which consists of an inner carbon body surrounded by insulating brick supported within a steel shell, forms the cathode. The anode consists of a row of pre-baked carbon blocks suspended in the cell from hanger rods attached to anode beams.

As current passes through the cell, molten aluminium accumulates on the surface of the cathode. Oxygen formed by electrolysis reacts with the carbon anode, burning it away.

Molten aluminium is removed periodically by vacuum syphon into crucibles for transfer to the cast shop.

The alumina content of the cell is maintained at between 2% and 6% by computer-controlled additions, and the anodes are replaced as they burn off.

During electrolysis a small amount of fume containing both hydrogen fluoride and sodium aluminium fluoride is given off.

To replace the fluoride lost, and to maintain the ratio of sodium fluoride to aluminium fluoride in the bath, additions are made of aluminium fluoride or cryolite. Some aluminium fluoride is also required to neutralise sodium compounds present as contaminants in the alumina feed. Also, if the smelter is operating a modified bath, then other additions may be required.

The cathode shell is not consumed during electrolysis. However, it is slowly eroded during operation, with failure usually showing itself by iron contamination of the metal. This is caused when the aluminium reaches the conductor bars of the cathode.

Cathode shells have a life of between five and eight years before they need to be replaced.

(b) Refining prior to casting

BREF Section 4.1.1.3

Process: When withdrawn from the reduction cells, the metal will contain sodium, hydrogen and some oxide particles, together with magnesium, calcium or lithium if these salts have been added to the bath.

The reactive metals can be removed by lancing in the holding furnace, or during casting by injecting gas into the metal. Mixtures of chlorine with nitrogen or argon are frequently used.

After gas treatment the metal is filtered to remove solid inclusions before casting.

Alloys can be made prior to casting by adding appropriate metals.

Drosses and skimmings are removed and recycled by secondary melters.

Water: The only water used in the process is cooling water in the casting shop. There is a minor risk of oil contamination, and contamination of storm water by dust from the site.

Aluminium & aluminium alloys

Air: There are potentially significant releases of oxides of carbon, polyfluorinated hydrocarbons (PFCs), particulates, hydrogen fluoride and metallurgical fume containing fluorides from the reduction cells. PFCs are released during anode effects. There is the potential for significant releases of sulphur dioxide from the cells, and chlorine, hydrogen chloride, oxides of nitrogen and metallurgical fume from the refining operations. Carbon oxides are generated during electrolysis and in smaller quantities as products of combustion arising from the casting shop and other operations. There are potential dust emissions from the extensive handling operations involving alumina and other dusty materials.

Waste: Cathodes removed from cells during periodic rebuilding represent a serious challenge. The carbon is saturated with fluoride salts, and also the nitrogen present in the original anthracite will have been converted into soluble cyanides.

The cast shop/refining operation will generate drosses which require treatment in secondary recycling plants, but nevertheless ultimately give rise to a waste.

Energy: Smelting aluminium is highly energy-intensive. A typical smelter will require between 14 and 16.5 kWh/tonne of metal. Energy efficiency in the cell is reduced if the alumina concentration falls below a critical level, causing an “anode effect”. For the duration of the anode effect, power consumption is dramatically raised, causing the cell to heat up.

Accidents: Out-of-control anode effects can cause the surface crust to melt, giving a massive increase in fluoride emissions.

Undetected weakening of cell walls can cause run-outs of electrolyte and metal, with much local fume and smoke.

Noise: Air pollution control equipment is on a massive scale, and proper attention must be given to design of fans and bag filter cleaning systems.

Application Form Question 2.3 (cont.) → Primary smelting of aluminium and aluminium alloys

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

BAT for primary smelting

BREF Section 4.2.2.1

Indicative BAT requirements

The main control issues are:

1. Electrolysis should be carried out using centre worked pre-baked cells with automatic multiple alumina feed points.

2. Cell process control is based upon active cell databases and monitoring cell operating parameters to minimise energy consumption and to reduce the frequency and duration of anode effects.

3. Complete hood coverage of the cells connected to a gas exhaust and filter is required. The cell hoods must be robust and extraction rates adequate. A sealed anode butt cooling system must be provided.

4. More than 99% fume collection from the cells is to be achieved on a long-term basis. Time taken to open hoods and change anodes is to be kept to a minimum. A programmed system is to be used for cell operations and maintenance.

5. Efficient cleaning methods should be used to remove fluorides from returned butts. The use of effective extraction and filtration is necessary in this area.

6. Where local, regional or longer-range environmental impact studies require reductions in sulphur dioxide emissions, low sulphur carbon should be used for electrode manufacture.

7. Treatment of primary exhaust gases is to use an alumina scrubber and fabric filter to remove at least 99.8% of fluorides present. The alumina used in the scrubber is to be recycled to the reduction cells.

Cont.

Aluminium & aluminium alloys

8. Exhaust gas from the anode bake furnace is to be treated to remove fluorides using an alumina scrubber and fabric filter. Tars and pitch fume from mixing and forming processes are to be treated using a coke filter.

2.3.2.2 Secondary melting and remelt of aluminium and aluminium alloys

BREF Section 4.3.4

SI 1973 Part A (b) and (c)

Process: This covers a wide range of activities, from remelting aluminium ingots or very clean aluminium scrap.

Furnaces used include:

- induction furnaces used for higher grades of scrap with limited contamination;
- reverberatory furnaces.

Water: There is limited risk of water contamination arising from storage of raw materials, e.g. swarf, and also furnace wastes such as slag or dross.

Air: Where salt fluxes are used, there is significant potential for air pollution.

Waste: Where furnaces are used to recover metal from lower grades of scrap, there is a potential for generating drosses and slags.

Energy: In all cases the energy requirements for recovering and remelting aluminium are but a small fraction of the energy required to make virgin metal.

Accidents: Where liquid chlorine is used to refine molten metal, all the potential for accidents associated with liquid chlorine exists. Otherwise the most frequently encountered accident will be associated with charging oily, greasy or plastic coated scrap – this will generate much smoke and heat in the exhaust system and may destroy the filtration plant. Other accidents such as may arise if water or munitions are introduced into the furnace can have catastrophic local effects, but are of limited environmental significance.

Application Form Question 2.3 (cont.)

Secondary melting and remelt of aluminium and aluminium alloys

BAT for secondary melting and remelt of aluminium and aluminium alloys

With the application the Operator should:

1. Supply the general Application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT Requirements

1. No additional requirement.

Aluminium & aluminium alloys

2.3.2.3 Extraction of aluminium metal from secondary raw materials

Process: Secondary raw materials from which aluminium is extracted are scrap metal, slags, drosses and engineering wastes such as swarf millings and turnings. The latter may be processed using swarf dryers as described in Section 2.3.1.3.

BREF Sections 4.1.2.3 and 4.1.2.4

SI 1973 Part A (1) (a)
Part B (b) when directly associated with a Part A (1) activity

The metal content of aluminium slags and drosses can be recovered by milling to break down the more friable non-metallic portion, then screening. The larger size fraction will contain most of the metal which can then be recovered. The following furnaces are used:

- reverberatory furnaces which are capable of handling larger pieces of scrap;
- rotary furnaces which can be used for metal reclaimed from drosses and slags, and a range of less clean raw materials.

Fluxes based on sodium chloride or mixtures of sodium and potassium chlorides are normally used in rotary furnaces where they aid heat transfer and protect small metal particles from oxidation. Wetting can be aided by minor additions of fluorides which can also assist in the removal of calcium and magnesium from the metal.

Smaller amounts of salt flux may be used in other furnaces to minimise metal loss through oxidation, and also to assist dross removal.

It is normal to avoid fluoride fluxes when using electric furnaces.

Some reverberatory furnaces fitted with after-burning systems are capable of handling scrap contaminated with oil, grease or paint; otherwise all such materials should be treated to remove contamination before being added to the melting furnace.

Water: No water is used in this process, but slags and drosses have a marked potential to contaminate water if they come into contact. Any leachate is likely to contain ammonia, dissolved salts and sulphide as well as suspended solids.

Air: Dry milling will give rise to dust and effective filtration is required. Materials must not get wet – see "Water" above.

Waste: Although some processes exist which promise to make beneficial use of the non-metallic portion of slags and drosses, these are not yet reliably established on a commercial scale. For most recovery processes there will remain a significant portion of unusable waste.

Accidents: Flooding of stocks of dross, slag or oily swarf can give rise to serious water contamination.

Noise: Milling operations are potentially noisy.

Application Form Question 2.3 (cont.) → Extraction of aluminium metal from secondary raw materials

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

BAT for recovery from aluminium drosses and slags

BREF Section 4.2.2.2

Indicative BAT requirements

1. Prevent emissions of dust and fume.
   - Use of enclosures or hoods provided with extraction to the fume arrestment system over charging, drossing and tapping areas.
   - Where possible, the use of sealed systems for feeding and for dross cooling.
2. Prevent unintended wetting of slags, drosses and recovered metallics handling and storing within waterproof buildings.

BAT for swarf dryers is covered in Section 2.3.1.3 above.

2.3.3 Lead, zinc and cadmium

2.3.3.1 *Primary smelting*

These metals are frequently associated in ores and concentrates, and a number of techniques are used to extract, separate and purify the metals.

(a) Smelting lead/zinc sulphide ores using the ISF blast furnace

BREF Sections 5.1.1.1, 5.1.5.1 and 5.5.1.7

SI 1973 Section 2.2 Part A (1) (a)

Process: The ISF production sequence is specifically designed to process mixed sulphide ores for the purpose of manufacturing lead and zinc. Sulphuric acid is manufactured as a by-product. Mercury, cadmium and precious metals are also recovered.

The concentrate is first blended with recycled fines and other recovered materials, then agglomerated into pellets in preparation for sintering. During the sinter process, the sulphide minerals burn to oxides and form a solid oxide mix which can be crushed and screened for charging to the blast furnace. The sintering reaction is exothermic and, once ignited, is self-sustaining.

The exhaust gases from the sinter strand carry with them all of the mercury, together with some of the arsenic present in the feed. They also contain cadmium and lead. The sinter gas is cleaned to remove and recover these elements, then passed to the acid plant for conversion to sulphuric acid.

The smelting furnace is a specially designed blast furnace, and is fed hot sinter and pre-heated coke. Air, sometimes enriched with oxygen, is blown in at the bottom, and the metal oxides present are converted to the metal.

At the operating temperature of the furnace, zinc and cadmium are vaporised, and carried off with the gases, whilst lead and slag are tapped as liquids.

The zinc vapour is condensed using a lead splash condenser, then refined in a two-stage fractionating column. In the first stage the molten zinc is fed into a column where all of the cadmium and most of the zinc are distilled. The vapours are condensed and fed to a second, slightly cooler column where the cadmium distils and is collected as a zinc–cadmium alloy. The metal run off is now 99.995% zinc.

The first stage run off, which contains lead, tin, iron, antimony and copper, is cooled and the lead recycled to the splash condenser. Zinc from this stage is cooled to remove iron and arsenic. Finally, it may be treated with sodium to convert residual arsenic and antimony as sodium arsenides or antimonides. This zinc is less pure than second-stage distillation zinc, but is free of cadmium and more suitable for galvanising.

The lead produced contains any precious metals present in the smelter feed, and will be subject to further refining (see Section 2.3.3.2 below)

Water: Wet scrubbers are used to treat various gaseous emissions prior to discharge. These give rise to liquid effluents contaminated with heavy metals. These must be treated before final discharge. The process involves handling a range of heavy-metal compounds in dusty form; some of these have significant solubility in water. The scale of likely operations is such that there will be a significant potential to pollute storm and groundwater.

Air: There is significant potential for air pollution arising from raw materials handling, sintering, smelting and refining operations.

Land: Pollution arising indirectly from emissions to air can be significant.

Waste: Smelting will give rise to a range of slags.

Recycling opportunities may be restricted by the accumulation of undesirable elements.

Energy: The scale of operation allows for significant recovery of heat from exhaust gases, and also for recovering the potential energy present in combustible exhaust gases.

Accidents: Loss of power to the air pollution containment system for either the blast furnace or the associated refining step would be potentially serious.

Application Form Question 2.3 (cont.)

Smelting lead/zinc sulphide ores using the ISF blast furnace

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

BAT for an integrated ISF smelting operation

Indicative BAT requirements

1. Emergency power should be provided for safety and environmentally critical systems to ensure that they are not deprived of power or water during reasonably predictable failure modes.
2. Vibration or other form of blockage detection is needed for the distillation stages.

2.3.3.2 Recovery of lead or zinc from secondary raw materials

(a) Recovery of lead from scrap batteries

BREF Section 5.1.2.1

SI 1973 Section 2.2 Part A (1) (a) or Section 2.2 Part A (1) (d)

Process: A typical lead battery can contain up to 30% lead alloy and up to 45% lead as the oxide or sulphate in a paste form. Scrap batteries are a major source of secondary lead, and if not reprocessed, constitute an important hazardous waste stream.

Whole battery treatment is not practised in the UK; instead, batteries are drained of acid and broken down by means of impact crushers. Crushed material is passed through a series of screening, wet classifying and filtration processes to provide separate fractions. These contain metallic components, lead oxide, sulphate paste, polypropylene, non-recyclable plastics, rubber and dilute sulphuric acid.

Prior to smelting, the lead sulphate paste is normally de-sulphurised by reaction with sodium carbonate or sodium hydroxide. This can reduce the amount of slag produced and the sulphur dioxide releases to atmosphere.

Smelting in the UK is predominantly carried out in:

- rotary kilns;
- ISA smelt furnaces.

Rotary furnaces are gas- or oil-fired batch operations which involve separate tapping of slag and metal. Most of the sulphur in the charge is fixed in the slag as a sodium–iron–sulphur compound.

In the ISA smelt process, de-sulphurised paste and reductant are continuously fed into the furnace, and lead bullion is periodically tapped. Fuel oil and air are injected through a steel lance submerged in the molten bath. When the process vessel contains the maximum volume of slag, additions of reductant and flux are made to produce a high antimony bullion and a discard slag.

Water: Risk of spillages of acid from raw materials handling.

Waste: Will include unusable materials arising from the breaking activity, slags from melting and filter plant dusts.

Air: Furnace operations will give rise to metallic fume, and some sulphurous exhausts and a possibility of acid mists.

Energy: Acid mists in exhausts limit the possibility of recovering energy from furnace gases.

Lead, zinc & cadmium

Application Form Question 2.3 (cont.)

Recovery of lead from scrap batteries

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

BAT for recovery of lead from scrap batteries

Indicative BAT requirements

1. Effective control of raw materials to prevent excessive accumulation.
2. Good design and maintenance of reception area to prevent acid spillage.
3. Reliable operation of breaker to ensure consistent feed to smelting furnace.
4. Good containment and reliable temperature control to prevent fugitive emissions of lead fume into the atmosphere.
5. Effective management of waste produced by the process, in particular to avoid accumulations and cross-contamination.

(b) Recovery of lead from other scrap and residues

BREF Section 5.1.2.2

SI 1973 Section 2.2 Part A (1) (a) and Section 2.2 Part A (1) (d)

Metallic lead may occur in a variety of forms, i.e. contaminated with plastic or bitumen, and alloyed with other elements, notably tin, antimony and silver.

Process: In some existing plants, clean scrap is melted in kettles, which are indirectly fired by gas or oil. Dross and tramp materials are skimmed from the metal surface and screened to separate, then the dross can normally be recycled.

For existing plant only, where scrap containing organic contaminants may be present, e.g. in cases where it cannot easily be segregated at source or at a treatment site, it may be melted in kettles. The gas extraction system and after-burner should be capable of extracting all of the gases from the melting pot during peak production of gases from the combustion of any material present, in particular during charging and drossing off. For a new plant, scrap containing organic contaminants should be melted in alternative processes.

Residues, including drosses and slags, together with metallic lead scrap, are smelted with fluxes in a rotary furnace.

Lead containing residues from the production of tetraalkyllead are melted in gas-fired reverberatory furnaces.

Water: Storm water contamination is the most significant source.

Waste: Includes those drosses which cannot be recycled, together with scrap plant items.

Air: Includes metallic fume from melting, also smoke and VOCs from organic contaminants.

Energy: Energy use is not high, and opportunities for energy recovery are limited.

Accidents: Failure on the melting pot allowing molten metal direct contact with the heating gases.

Failure of temperature controller causing furnace to overheat.

Fires in fabric filters caused by the carry-over of incandescent particles.

Application Form Question 2.3 (cont.)

Recovery of lead from other scrap and residues

BAT for recovery of lead from scrap other than battery scrap

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BREF Chapter 5.4.2.2

1. Effective purchasing and sorting procedures to ensure that unsatisfactory material is not charged to the melter. Where materials with organic contaminants such as pitch are to be processed, then the furnace design should be such as to permit adequate combustion of evolved gases and smoke.
2. Good temperature controls with failsafe system to prevent overheating.
3. Kettles should only be used for clean lead.

(c) Refining lead

BREF Section 5.1.3

SI 1973 Section 2.2 Part A (1) (b) or Section 2.2 Part A (1) (d)

Process: Lead produced from both primary and secondary processes may contain varying amounts of copper, silver, bismuth, antimony, arsenic and lead.

UK lead refineries are pyro-metallurgical, consisting of a series of kettles indirectly heated by oil or gas. Copper is removed first as a sulphide dross, following sulphur additions if necessary.

Arsenic, antimony and tin are removed as an oxide dross following reaction with a mix of sodium nitrate and caustic soda. Air can also be used as the oxidising agent.

Silver is collected by addition of zinc and removed in an intermetallic crust of zinc and silver. Zinc is removed from the crust by vacuum distillation and fine silver is produced following further refining with oxygen.

Calcium and magnesium are used to remove bismuth by forming a calcium–magnesium–bismuth alloy dross, which is removed by skimming. The dross is then oxidised using lead chloride, chlorine gas as a caustic soda/sodium nitrate mixture, and the calcium magnesium oxide is removed by skimming. A bismuth–lead alloy is recovered and undergoes further refining to produce bismuth.

The pure lead is cast into blocks or ingots. Fume, drosses and other residues can be recycled by smelting in a rotary or small blast furnace.

Water: The process does not require water. Potential contamination of storm water must be avoided.

Waste: Drosses that cannot be recycled may contain arsenic and are potentially hazardous if exposed to moisture.

Air: The process involves removal of dry drosses and has potential for generating dusts rich in heavy metals.

Metallurgical fume can be generated at the metal surface.

Accidents: Overheating molten metal caused by control failure, or by failure of container allowing metal to spill into firing zone.

Application Form Question 2.3 (cont.) — Lead refining

With the application the Operator should:

1. Supply the general Application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for lead refining

1. Good temperature controls with failsafe system to prevent overheating.
2. Collection and filtration of dust and fume from drossing operations.

(d) Melting and alloying processes for lead

BREF Section 5.1.4

SI 1973 Section 2.2 Part A (1) (b) or Section 2.2 Part A (1) (d)

Process: Melting and alloying are usually carried out in indirectly heated crucible furnaces or kettles, using electricity, oil or gas. Refined lead is melted in a kettle and alloying elements are added, taking care to control temperature.

Lead and lead alloys can be cast into permanent cast iron moulds or into ingots using conveyor-type casting machines, or into rod or sheet, using continuous casting machines.

For potential issues and BAT see Section 2.3.3.2.(c) above.

(e) Recovery of zinc from scrap, dross and other residues

BREF Section 5.1.6

SI 1973 Section 2.2 Part A (1) (a)

Residues and scrap which are relevant and significant to the UK secondary zinc industry include:

- dust from copper alloying;
- residues from the die casting industry;
- galvaniser's ashes;
- residues from the shredding of steel scrap, including scrap cars;
- zinc drosses;
- hard zinc or spelter;
- zinc oxide from the burning of tyres.

Process: The process route for zinc recovery depends on the form and concentration of zinc, and the degree of contamination.

Galvaniser's ashes are essentially a mixture of zinc metal and zinc oxide contaminated with ammonium and zinc chloride. They are both milled and classified or screened to separate the non-metallic phase from the coarser, heavier metallic phase. The metallic fraction is then melted and cast.

Hard zinc or spelter is an alloy of zinc, iron and lead which forms and accumulates in holding furnaces and galvanising tanks. Top dross is a zinc–iron–aluminium alloy generated from hot dip galvanising. Drosses, skimmings and other residues from the die cast industry contain a mixture of zinc metal and oxide with little or no chloride. A variety of treatment schemes are used for these materials, including physical separation, chloride removal, melting and casting.

Processing scrap vehicles in a series of mills produces shredder residue. This is subjected to a range of techniques designed to separate the ferrous, non-ferrous and non-metallic fractions. The non-ferrous fraction is melted in two stages in a gas-fired reverberatory furnace, which allows lead to be tapped first at 340°C, followed by zinc at about 440°C. An alternative process uses an indirectly fired rotary kiln with a perforated inner liner, through which zinc flows preferentially to a holding furnace.

Lead, zinc & cadmium

Water: The processes do not normally use water.

Waste: Potentially hazardous wastes are produced.

Air: Raw materials handling and waste handling are potentially dusty.

Operations involving molten zinc are potential sources of metallurgical fume.

Accidents: If drosses which contain arsenic are allowed to come into contact with water, then arsine can be formed.

Noise: No special significance.

Potential pollutants and BAT comment as per Section 2.3.3.2.(c) above.

(f) Melting and alloying processes for zinc

BREF Section 5.1.7

Process: Melting and alloying are usually carried out in indirectly fired crucible furnaces or induction furnaces with strict temperature controls, to prevent metal fuming.

Alloy additions can be in either solid or molten form.

When alloys are made from impure, raw materials, fluxes containing zinc chloride, magnesium chloride and sodium silicofluoride may be used. This will result in the release of gaseous silicon tetrafluoride, which can only be removed by hydrolysis to hydrogen fluoride in a wet scrubber.

Potential pollutants and BAT comment as per Section 2.3.3.2.(c) above.

Precious metals

BREF Section 6

2.3.4 Precious metals

Activities involving precious metals can be conveniently subdivided into those involving silver, those involving gold, and those relating to the platinum group (PGMs). There are a wide variety of processes in use, many of which are commercially confidential. Some examples of processes are given below.

2.3.4.1 Silver

(a) Secondary smelting operations

BREF Section 6.1.1.1

Process: Photographic film, papers and sludges are incinerated in a rotary kiln to produce a silver-rich ash. The exhaust gases must be treated to destroy dioxins and to remove acid gases and particulates before discharge into the atmosphere. The ash from the kiln can be blended with other materials to be smelted, mixed with binder and fluxing agents and formed into pellets.

The silver containing residue is smelted with either copper or lead oxides. Normally a rotary furnace is used for the copper route and a blast furnace for the lead route. The metals act as a carrier for the silver and are subsequently oxidised to separate them in a cupellation furnace or within the rotary furnace using an excess of oxygen.

Metal and slag are discharged continuously from the tap hole. Accumulated slags are re-run through the furnace to minimise waste before granulation and disposal.

Gases are collected and filtered before discharge.

Water: Is used as a coolant, and may also be used as a gas scrubbing medium. The dusty nature of the raw materials and intermediates gives opportunities for surface water contamination.

Waste: Include blast furnace slags and waste refractory generated during maintenance.

Air: Dioxins may be generated during the incineration operation. Photographic emulsions may be gelatine based, in which case inadequate incineration can give rise to foul odours. Incinerator ash is dry, dusty and easily blown. The smelting and cupellation stages can give rise to fume containing lead and silver. Any mercury which enters the system will be discharged at the smelting stage.

Energy: The potential for dioxin formation at the incineration stage is such that high-temperature after-burning is likely to be necessary. Heat recovery and re-use will be necessary.

Noise: Fans and filters to minimise emissions to air are the major potential source.

Accidents: Failures in the extraction system causing emissions of untreated gas to air.

Fire in the paper or film storage hopper causing air and water pollution.

Application Form Question 2.3 (cont.) → Secondary smelting of silver

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for secondary smelting of silver

1. Raw materials receipt, storage and blending facility designed so as to ensure consistent feed to incinerator and smelter. Also to ensure that unsuitable materials are not used.
2. Minimise dioxin releases from incinerator by passing exhaust gases through an after-burner operated at 1100°C, with 6% v/v oxygen present in the exhaust. After leaving the after-burner, the gases must be quenched rapidly to below 160°C to avoid synthesis of dioxins.
3. Minimise release of particulate, and of acid gases formed by decomposition of chlorides and bromides in film, by dry scrubbing.
4. Recover energy from hot exhaust gases.
5. Prevent losses of metallurgical fume by effective design, construction and maintenance of extraction and filtration systems.
6. Avoid generation of water wastes by using dry scrubbing systems.
7. Fit effective fire detectors and extinguishers to incinerator storage hopper.
8. The copper route may have a lower environmental impact.

(b) Silver remelting operations

SI 1973 Section 2.2 Part A (1) (f)

Process: Scrap silver artefacts are crushed and melted down in small, gas-fired pot furnaces.

There is a potential risk of emissions to air which contain cadmium.

Certain silver alloys, in particular those used for soldering, contain significant amounts of cadmium, some of which is lost during this operation.

Application Form Question 2.3 (cont.) → Silver remelting operations

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for silver remelting

1. The class of permit required for any silver remelt operation should be assessed against SI 1973 Section 2.2 Part A (1) (f).
2. If any of the alloys being handled contains more than 0.05% cadmium, then extraction and filtration equipment is necessary.

Precious metals

2.3.4.2 Gold

(a) The Miller process for purification of reclaimed gold

BREF 6.1.2.1

SI 1973
Section 4.2
Part A (1) (b)

Process: Gold recovered from industrial, dental or jewellery uses will contain a number of base metals including tin, copper and zinc. In the Miller process the impure gold is heated in an indirectly heated crucible or electric furnace to 1000°C. Chlorine gas is then injected into the metal, and at this temperature gold is the only metal which does not react to form a stable liquid or volatile chloride. Molten silver chloride rises to the surface of the melt. Other metals are driven off as volatile chlorides and are collected as a slag by adding borax flux. The product may be further refined electrolytically if required.

The metal chlorides are hygroscopic to a greater or lesser degree. The characteristics of the fume produced will vary from process to process and will consequently affect the selection of abatement plant. Two-stage alkaline wet scrubbers are required to cope with this hygroscopic material and to remove any excess chlorine. If significant quantities of zinc are present, then the exhaust must be warmed above the dew point and filtered.

Air: Excess chlorine, condensed chlorides and other metallurgical fume are generated.

Water: Contaminated water must be disposed of.

Waste: Dross, skimmings, filter bags, furnace liners and most other solid wastes from this process are recycled to smelters. The scale is in any case very small.

Noise: Is insignificant.

Accident: There is a potential for loss of containment on the chlorine system.

Energy: The small scale of the operation renders heat recovery impracticable.

Application Form Question 2.3 (cont.) → The Miller process for purification of reclaimed gold

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for the Miller process

1. Control system to control the temperature of the melt and rate of lancing to minimise loss of chlorine gas.
2. A scrubbing system to remove vaporised metal chlorides and metal oxides.
3. Effective treatment for scrubber effluent.

2.3.4.3 Platinum group metals

BREF 6.1.3

SI 1973
Section 2.2
Part A (1) (a)

The six platinum group metals (PGMs) are platinum, palladium, rhodium, ruthenium, iridium and osmium. They are characterised by their high melting points, high densities, good electrical conductivity, resistance to corrosion and their ability to catalyse many gas-phase chemical reactions. Hence they are widely used as catalysts, electronic and electrical components, in industrial plant fabrication and for jewellery.

PGMs occur naturally at trace levels in sulphidic ore deposits of nickel and copper in South Africa, Russia and Canada. Gold and silver are also to be found in the same deposits, and residues from nickel and copper refining are a primary source of precious metals.

Because of the high value of precious metals, recycling is also important and recovers a large proportion from fabricated products.

The range of potential raw materials is very wide and techniques must be adapted to the materials to be processed. Not all of the activities described below will be encountered on all sites, and similar ends may be achieved using alternative techniques.

Precious metals

The process description below is presented in order to illustrate the complexity which may be encountered at installations engaged in recovering and purifying platinum group metals. Other process routes may be equally acceptable as BAT.

Process: **Pre-treatment –** Catalysts frequently consist of a small amount of metal on an inert base. Carbon based catalysts are incinerated to remove carbon prior to dissolution. Similarly, ceramic based catalysts are incinerated to remove residual carbon and hydrocarbons, and then subjected to further treatment with sodium hydroxide or sulphuric acid to dissolve the ceramic component. Some raw materials require more aggressive conditions; in some cases this is achieved by operating at higher pressure, in other cases by the use of aqua regia.

Hydrometallurgical processing – *Dissolution* is effected by first finely grinding the feedstock, then treating it with hot hydrochloric acid through which chlorine is passed. Some raw materials require more aggressive conditions; in some cases this is achieved by operating at higher pressure, in other cases by the use of aqua regia.

When optimum dissolution has been achieved, the solution is filtered to remove insoluble material including silver as silver chloride. Initially, osmium and ruthenium are removed as their volatile tetroxides by oxidising with sodium bromate. These are recovered by scrubbing with hydrochloric acid where they are converted to chlorides. Osmium is separated by further *selective oxidation* and distillation to yield a pure solution of osmium chloride. Both are recovered by precipitation with ammonium chloride. The solution containing the remainder of the precious metals is filtered, acidified and treated to remove gold.

Gold is removed by *solvent extraction,* using an oxygenated organic solvent into which the gold is selectively extracted. The gold is subsequently removed from this solvent by reduction, e.g. by oxalic acid.

Palladium is also recovered using solvent extraction techniques, this time using a different solvent, such as a thio-ether. After extraction, palladium is recovered from the solvent as a tetrammine complex using aqueous ammonia. The solution is neutralised and the salt reduced with formic acid to yield palladium black. Solvent extraction techniques are next used to recover platinum from the palladium raffinate, one such solvent being tributyl phosphate. The organic phase is stripped with water from which platinum is recovered as ammonium hexachloroplatinate.

By this stage the raffinate now contains only rhodium and iridium. The solution is subjected to an ion exchange process to extract iridium, which is precipitated from the ion exchange strip liquors using ammonium chloride.

In order to purify the rhodium stream, the rhodium liquor is subject to various chemical treatments. One such route involves precipitation of an ammonium nitro-rhodium salt. This is then converted to ammonium hexachlororhodate by the action of hydrochloric acid and finally reduced to rhodium black using formic acid. The hydrometallurgical stages are concluded by an *ignition* step, where ammonium salts and blacks undergo thermal decomposition, some of which require an inert or reducing atmosphere. The recovered metals are milled to produce fine powders or melted and cast into ingots.

Smelting – This is used to upgrade materials where the amount of PGM is too low for efficient hydrometallurgy. Lead smelting is used to upgrade the material which also provides an efficient route for the recovery for silver. The raw materials are mixed with lead carbonate, carbon and fluxing agents such as soda ash, lime borax or silica sand. In the smelting operation the mix is heated to 1100°C during which lead dissolves silver and precious metals while base metals concentrate in the slag. On tapping, the lead and slag separate and the slag is removed. The lead is parted to recover the precious metals and the silver recovered as silver chloride which is ultimately electro-refined to produce pure silver. The lead is converted to carbonate for re-use.

Water: Waste liquors are generated after each of the filtration stages to yield a pure metal compound. Waste liquors are also generated by scrubbers that are used to prevent the emission of acid gases, halogens of ammonia, into the air. Significant volumes of liquids are handled with an associate risk of spillage.

Air: *Pre-treatment incineration* has a potential to release dusts, odour and PICs. *Dissolution* involves handling chlorine and hydrogen chloride. When aqua regia is used, oxides of nitrogen and nitrosyl chloride are generated. Ammoniacal solutions are used in some of the solvent extraction phases. *Decomposition* of complex compounds containing ammonium chloride give rise to hydrogen chloride and ammonium chloride fume.

Ammonia obtained from cylinders of liquid ammonia is cracked to generate the protective atmosphere used in the decomposition furnaces. *Materials handling* operations are potential sources of dust, and some of the compounds involved are highly toxic. Fire refining generates a metallurgical fume that contains lead.

Wastes: The very high value of platinum group metals means that most residues from extraction processes are returned for further processing in primary smelters. Very little waste is generated by this activity.

Energy: The high toxicity and potential environmental impact require comprehensive containment and treatment systems for all emissions. Energy efficiency of necessity takes second place to effectiveness and reliability.

Accidents: Liquid chlorine and liquid ammonia are used on-site, therefore there are risks associated with loss of containment. Major spillages of reaction liquids could cause water contamination. The solvent extraction system may involve the use of flammable solvents.

Noise: Accidental noise from vehicle movements. Noise from fans and pollution abatement equipment.

Application Form Question 2.3 (cont.) — Platinum group metals refinery

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for platinum group metals

BAT for platinum group metals refinery should include

1. Attention to process design and stock control so as to minimise inventories of liquefied gases and flammable solvents.
2. Process control systems designed to minimise the reagent requirements and losses from the reactor to the fume control system of gases such as ammonia, chlorine and hydrogen chloride.
3. Adequate bunding of all storage tanks and reactors. Effective pipework design to ensure that pipe ruptures do not drain outside bunded areas.
4. Efficient liquid stock management to ensure tanks are not overfilled. Comprehensive alarm systems to cater for mistakes.
5. Effective procedures for identifying solid materials in process or awaiting dispatch.
6. Effective dust control procedures in all areas where potentially dusty materials may be handled. The nature of the procedure must take due cognisance of the toxicity of the material being handled.
7. Comprehensive treatment systems to minimise emissions into the atmosphere of acid gases, halogens, oxides of nitrogen, ammonia, metallic fume and particulate matter of any description.
8. Comprehensive treatment systems to ensure that liquid discharges meet acceptable limits before discharge.

Refractory metals

2.3.5 Refractory metals

The term "refractory metals" includes chromium, manganese, tungsten, vanadium, molybdenum, titanium, tantalum, niobium and rhenium.

BREF Section 8.1.1

Historically, the United Kingdom was a leader in the production and use of many of these elements, but in the closing decades of the 20th century this position was lost. For most of these metals there is now no UK production capacity and there is little prospect of new capacity.

Since many of these elements are used in the manufacture of alloy steels, production is in the form of ferro alloys, as described in Section 2.3.6.

2.3.5.1 Chromium

BREF Section 8

SI 1973 Section 2.2 Part A (1) (a) (i)

Process: Chromium metal can be made from chromite ore and concentrates by first reacting the ore with sodium carbonate to form chromates. These are extracted by leaching the fused mass with sulphuric acid to produce sodium chromate which is first converted to chromic acid and finally to chromic oxide. The oxide is then mixed with carbon, silicon or more often aluminium powder. It is then fired to initiate a thermite reaction. The heat generated by the aluminium thermite reaction is sufficient to melt the chromium, which is recovered as a button from the pot.

Water: The leaching operations involve aqueous solutions of hexavalent chromium with a high pollution potential.

Air: The thermite process is vigorous and intensely hot, with a high potential for discharge of a metallurgical fume containing chromium.

Land: Escaping dust and fume may contaminate land.

Waste: The quantity of waste generated by the initial fusion and leaching operation will be affected by the purity of the ore or concentrate used. The residue will contain unreacted chrome ore and soluble salts. The life of pots is short, and these together with slags will need to be disposed of.

Accidents: The leaching stages involve handling solutions of hexavalent chromium. The potential for environmental damage in the event of spillage is high. The thermite stage, once started, cannot be stopped before reaction is complete. Any failure of the plant or accidental pre-ignition will give rise to severe local fumigation.

Energy: The manufacture of chromic oxide requires significant energy input, involving successive leaching and evaporation stages. The thermite process itself is markedly exothermic, but nevertheless an energy consumer by virtue of the absence of control on heat release, and also the need for substantial extraction systems to prevent air pollution.

Noise: Not significant.

Application Form Question 2.3 (cont.) | Chromium metal manufacture

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for manufacture of chromium metal

1. Effective control of the leaching and concentrating stages in order to prevent water pollution.
2. Prevention of fugitive discharges into the air during roasting and the thermite process.
3. Minimisation of solid waste production by ore pre-treatment.

Refractory metals

2.3.5.2 Manganese

BREF Section 8.1.2

This section lists the following processes for the production of pure manganese:

- electrolysis of aqueous maganese salts
- electro-thermal decomposition of ores
- silico-thermic reduction
- alumino-thermic reduction
- distillation of ferro-manganese
- electrolysis of fused salts.

Only the first two are economically significant, and none are carried out in the United Kingdom.

2.3.5.3 Tungsten

(a) Production from ores or concentrates

BREF Section 8.1.3

SI 1973 Section 2.2 Part A (1) (a)

Process: Tungsten is abstracted from concentrates by pressure leaching with caustic soda to yield a sodium tungsten solution. After removal of impurities, this is converted to ammonium paratungstate (APT) by either solvent extraction or ion exchange. The APT is removed by evaporation and crystallisation. It is then calcined to make either yellow (WO_3) or blue (W_4O_{11}) tungsten oxides. The yellow oxide forms at 250°C, but the blue oxide requires an inert atmosphere and temperature between 400°C and 800°C. Blue oxide is preferred since less reducing agent is required at later stages.

Reduction to tungsten metal powder is achieved by heating the oxide in hydrogen in a rotary furnace or band furnace.

Water: The initial leaching phase will generate a liquid waste.

Air: Dust releases are possible whenever dry materials are handled. Ammonia is consumed and then evolved as the process proceeds.

Waste: Significant quantities of sludge are generated by the leaching process. However, tungsten is not normally imported at this stage, and wastes from handling APT are not significant.

Accidents: Not significant.

Noise: Not significant.

Application Form Question 2.3 (cont.) — Tungsten manufacture

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for tungsten manufacture

1. Prevention of liquid losses during leaching stage.
2. Treatment and safe disposal of solid residues.
3. Prevention of loss of ammonia to air.
4. Prevention of dust losses to air.

Refractory metals

(b) Processing tungsten secondary raw materials

BREF Section 8.1.3.2

Two major processes are available for processing tungsten carbide scrap:

- The Goldstream process involves blowing fragmented carbide tool ends at below ambient temperatures against a stationary target. Adiabatic cooling shatters the embrittled carbides which are then air classified for re-use.
- The zinc process involves treating the carbide rod with molten zinc which forms an amalgam with the cobalt matrix. The tungsten carbide is left as a spongy matrix which can be crushed and re-used. The zinc is recovered by distillation.

Tungsten carbide scrap, which cannot be recovered by the above methods, can be oxidised and converted to APT, then processed in accordance with the primary cycle.

2.3.5.4 Vanadium

BREF Section 8.1.4

The only vanadium produced in the UK is in the form of the ferro alloy – see Section 2.3.6.

2.3.5.5 Molybdenum

(a) Roasting sulphide ores

BREF Sections 8.1.5 and 9.1.6.1

SI 1973 Section 2.2 Part A (1) (i)

Process: Molybdenum occurs as a sulphide, either alone, or in combination with copper. The ore is crushed and the molybdenite present separated by flotation.

Conversion to molybdenum trioxide is achieved by roasting, which produces sulphur dioxide, which can then be converted into sulphuric acid. Selenium and rhenium may also be present in the concentrate, and if so, will need to be removed from the gases before the acid plant.

Water: Potential losses associated with operation of acid plant.

Air: Dust from handling raw material and product. Loss of sulphur dioxide to air, and dust from filtration plant fines.

Waste: Gangue from flotation plant, solids from filtration system and sludges from acid plant.

Accidents: Loss of extraction leading to significant acid gas releases.

(b) Production of molybdenum metal

BREF Section 8.1.5.1

SI 1973 Section 2.2 Part A (1) (a)

Process: Molybdenum metal can be produced from molybdenum trioxide, ammonium hexamolybdate or ammonium dimolybdate by heating the compound in a hydrogen atmosphere.

The process takes place in two stages:

- The first is the production of molybdenum dioxide. This is exothermic and takes place at about 600°C.
- The second stage requires heating of the dioxide in hydrogen to 1050°C, usually in a counter-current rotary kiln. The metal can then be compressed and sintered, or alternatively the powder melted in a vacuum arc furnace.

Water: Water is not used. Small-scale process.

Air: Products of combustion.

Waste: Negligible.

Land: Negligible.

Energy: The small scale and high temperatures make the process relatively inefficient.

Accidents: With hot hydrogen there is always a possible implosion risk.

Refractory metals

BREF Section 8.1.5.2

SI 1973 Section Section 4.2 Part A (1) (a) (v)

(c) Recovery of molybdenum from secondary materials

Molybdenum and vanadium catalysts are widely used in the petrochemical industry. The metals are recovered as their oxides by:

- heating in air to 600°C to remove sulphur, carbon and hydrocarbons – this converts the metals to their oxides;
- leaching out the molybdate and vanadate;
- separation of molybdate and vanadate;
- treatment of alumina support to recover cobalt and nickel.

BREF Section 8.1.6.1

SI 1973 Section 2.2 Part A (1) (a)

2.3.5.6 Manufacture of titanium

Process: Titanium sponge is manufactured by reducing titanium tetrachloride with magnesium metal in an inert atmosphere. The reaction is exothermic and the rate of reaction controlled via the rate of addition of titanium chloride. The operating temperature is in the range 850°C to 950°C.

The sponge is intimately mixed with magnesium chloride, unreacted magnesium, titanium tetrachloride and other chlorides of titanium.

Purification is achieved by:

- acid leaching, using dilute nitric or hydrochloric acid; or
- heating under an inert atmosphere or a vacuum to 1000°C.

The titanium sponge can be melted using a consumable electrode vacuum arc melting process.

Water: There is negligible opportunity for water pollution.

Air: Planned releases are insignificant.

Land/waste: As high-purity compounds are used, wastes are insignificant.

Energy: The titanium chloride and metallic magnesium are "high-energy" raw materials, but apart from these and the arc furnace, little extra energy is needed.

Accidents: Titanium tetrachloride will react vigorously with water or moist air to give dense white fumes of hydrochloric acid and titanium dioxide particulate. Any accidental spillage will therefore have considerable local impact.

Application Form Question 2.3 (cont.) — Titanium manufacture

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for titanium manufacture

1. Effective storage and handling systems to prevent loss of the titanium chloride.
2. Well-rehearsed emergency procedures to handle any accidental spillage.

BREF Section 8.1.7

2.3.5.7 Tantalum

No processes defined in SI 1973 are in operation in the UK.

BREF Section 8.1.8

SI 1973 Section 2.2 Part A (1) (a)

2.3.5.8 Niobium

Process: Small amounts of niobium are ferro-niobium and nickel niobium alloys by the aluminium thermite process. This is similar to the process used to manufacture chromium as described in Section 2.3.7.1.

Ferro alloys

BREF Section 9

SI 1973 Section 2.1 Part A (1) (b)

2.3.6 Ferro alloys

A major use of elements such as chromium, vanadium, silicon and manganese is as constituents of alloy steels. Since it is frequently more convenient to add these elements to steel in the form of master alloys, they are frequently manufactured in this form.

Depending upon the raw materials used, the process can be classified as primary or secondary, the principles being:

- **Primary** – metal oxide/ore with iron ore/scrap plus reductant combine to yield ferro alloy and reductant oxide and slag.
- **Secondary** – metal scrap plus iron scrap yields ferro alloy.

The reductants most frequently used are carbon, silicon and ammonium.

2.3.6.1 Ferro-chrome

BREF Section 9.1.1

Process: The main raw material is chromite ore, which contains a mixture of iron and chromium oxides. For high carbon ferro-chrome (the most frequently used), coke is used as the reductant. Fluxing agents are added to aid slag formation.

Before charging to the electric arc reduction furnace the raw materials are normally pelletised then sintered.

During smelting, the metal oxides are reduced and ferro-chrome and slag must be tapped at regular intervals from the furnace.

Reduction produces large volumes of carbon monoxide, which can be drawn off, cleaned then burned as a fuel for pre-heating, drying or similar processes.

The slag can be crushed to recover entrained metal, and is sufficiently inert to permit its use in civil engineering.

Water: Significant quantities are used as coolant and for slag granulation.

Waste: The quantity of slag generated is mainly influenced by the quantity of ores used. Other wastes include furnace refractories and filtration plant dusts.

Air: There is significant potential for air pollution, important potential sources being raw material handling and furnace operation.

Energy: This is a high-energy operation and there are significant opportunities for minimising energy use, namely:

- raw materials selection to minimise slag generation;
- heat recovery from hot exhaust gases prior to cleaning;
- recovery of energy value of CO by using exhaust as fuel gas.

Noise: Arc furnaces can be very noisy.

Application Form Question 2.3 (cont.)

Ferro-chrome production using arc furnace technology

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for ferro-chrome production using arc furnace technology

1. Effective control over raw materials acquisition to ensure optimum feed to the process.
2. Dust control.
3. Fume control.
4. Energy recovery.
5. Minimisation of waste-water generation.

Ferro alloys

2.3.6.2 Other ferro alloys

Ferro silicon, ferro-manganese, ferro-nickel and ferro-boron can be produced using arc furnace technology, which is substantially similar to that described in Section 2.3.6.1.

BREF Section 9.1.7.1.1

Ferro-tungsten can also be made in an arc furnace, though due to its high melting point, it cannot be removed by tapping. Instead, when the amount of metal has reached the desired weight, the furnace is switched off and allowed to cool. The refractory is removed and the ingot taken for crushing and screening.

2.3.6.3 Production of ferro-manganese in blast furnaces

BREF Section 9.1.3.3.1

Process: Ferro manganese can be manufactured in blast furnaces which resemble those used to manufacture pig iron. The reaction sequence and heat balance are more complex as a consequence of the wide range of oxides which can be formed by manganese.

The higher oxides (MnO_2, Mn_2O_3, and Mn_3O_4) are reduced by carbon monoxide near the furnace top. The reaction is exothermic and leads to a relatively high exhaust temperature.

Further reduction requires high temperatures and is markedly endothermic. Consequently the furnace requires much more coke or supplementary fuel than a similar iron furnace. Also, more gas is generated than can be used on pre-heating stoves.

Energy: As a consequence of the high energy and coke requirements, production of ferro-manganese in a blast furnace is not likely to be considered BAT when compared with an arc furnace.

No other issues considered.

2.3.7 Alkali and alkaline earth metals

2.3.7.1 Sodium metal

BREF Section 10.1.1

SI 1973 Section 2.2 Part 1(1) (a)

Process: Sodium metal is produced by the electrolysis of fused sodium chloride. The first stage in the process is the preparation of pure salt from crude salt. Calcium and barium chlorides are added to the electrolyte to reduce the melting point and to increase its density.

The Downs cells used have a cylindrical anode which is separated from the concentric cathode by a steel mesh diaphragm. The purpose of the diaphragm is to minimise contact between the products of electrolysis, namely chlorine and sodium.

Chlorine is drawn off at the surface, liquefied and stored in storage tanks prior to sale. The sodium also rises to the surface of the melt, and is gathered by a collector assembly from which it runs into receivers which are tapped at regular intervals.

Small amounts of calcium are also formed, and this solidifies from the molten sodium as the latter cools.

After the calcium has been removed by filtration, the molten sodium is transferred to hot storage tanks pending use on the chemical process, or sale.

Water: The first stage of the process involves purification of salt by dissolution and recrystallisation. There is a small bleed to remove soluble impurities in the incoming salt.

Air: Large quantities of chlorine are generated and stored during this process.

Molten sodium in contact with air fumes violently and is prone to fire.

Waste: Not significant.

Energy: The process is energy-intensive, involving a dissolution and recrystallisation stage as well as the electrolysis step.

Noise: Not significant.

Accidents: Chlorine leaks and spillages. Spillages of molten sodium. Fires.

Application Form Question 2.3 (cont.) → Sodium metal

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for sodium metal

1. Operating and maintenance procedures shall be devised so as to minimise the amount of sodium which comes into contact with air.
2. Chlorine collection storage and handling systems shall comply with the requirements for chlor – alkali production.
3. Emergency power supplies for chlorine extraction fans.
4. Emergency scrubbing systems capable of absorbing chlorine production to allow for emergency shut-down.
5. Comprehensive fire and emergency procedures with provision for regular and realistic drill.

2.3.7.2 Lithium

BREF Section 10.1.2

Lithium metal is also produced by fused salt electrolysis using Downs cells.

Apart from using lithium chloride as the main electrolyte, the process differs in the following details.

Lithium is much less reactive and can be skimmed off and cast into moulds. These are covered with oil to prevent oxidation.

Much smaller quantities of lithium are manufactured, and consequently the quantity of chlorine is not sufficient to warrant recovery as gas. Instead it is used to manufacture sodium hypochlorite for sale.

There are no releases to water, and the risk of fire is much reduced. Otherwise the factors and requirements are similar to Section 2.3.7.1 above.

2.3.7.3 Magnesium

Magnesium is manufactured by electrolysis of fused magnesium chloride.

BREF Section 10.1.5.2

Magnesium hydroxide is first prepared by slaking calcined dolomite with sea water. The hydroxide is then recovered by concentrating the solids to a pulp in a thickener, then drying and calcining in a rotary kiln.

The magnesium oxide is then mixed with carbon and pelletised prior to charging into chlorinator towers. These are brick-lined shaft furnaces into the base of which chlorine from the electrolysis is fed.

The towers are run at temperatures above the melting point of the magnesium chloride, which is withdrawn and transferred via closed vessels to the electrolysis cells furnace.

From the cells, molten magnesium is withdrawn and transferred in closed cells to the cast house where the metal is cast as ingot or alloy. Sulphur hexafluoride can be used to prevent oxidation during casting.

Off-gases from the chlorination furnaces are scrubbed to remove chlorine and passed through precipitators to remove dusts before finally being subject to incineration.

Water: Contaminated water from the chlorinator off-gas treatment plant will require treatment before discharge.

Air: Dusts arising from the calcination process.

Chlorine from the electrolysis process.

Magnesium oxide from molten metal handling.

Waste: Not significant.

Noise: Not significant.

Energy: Preparation of magnesium chloride has a high energy demand, as does its electrolysis.

Accidents: Chlorine gas is being generated in quantity and transferred between stages.

Molten magnesium is being handled.

Application Form Question 2.3 (cont.) — Magnesium metal

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for magnesium metal

Issues which must be considered in assessing BAT are:

1. Water effluents from the precipitation process.
2. Products of combustion and associated gas cleaning from the calcination process.
3. Fugitive emissions of chlorine from the electrolytic reduction process.
4. Fugitive emissions of magnesium oxide from metal transfer and casting operations.
5. Emergency systems to prevent losses of chlorine during power failure.

2.3.7.4 Calcium and strontium metal

BREF Section 10.1.4

Small quantities of calcium or strontium metal can be manufactured by a metallo-thermic reaction using the relevant oxide and aluminium powder.

The oxide is ground and mixed with aluminium powder, then pressed into briquettes.

These are heated to 1300°C in a vacuum furnace, at which temperature the calcium (or strontium) distils off and can be condensed in the cooler part of the furnace.

A very small-scale process with limited potential for pollution.

Nickel

2.3.8 Nickel

Nickel is produced from oxide or sulphide ores, with about 60% of production coming from the latter.

Neither ore is processed in the United Kingdom, but the carbonyl process is used to refine an imported oxide prepared by smelting sulphide ore.

2.3.8.1 The carbonyl process

BREF Section 11.1.3.5

Process: Impure nickel oxide is first reduced to nickel powder using hydrogen. It is activated and then exposed to carbon monoxide at near ambient temperature and pressure, when it reacts to form nickel carbonyl. The carbonyl is volatile and easily separated from the residue. It is also thermally unstable, and when warmed it readily decomposes to yield nickel and carbon monoxide. Depending upon the structure of the reactor and the reaction temperature, the product can be obtained as pellets, as powder, or as a nickel coating on other materials.

The recovered carbon monoxide is recycled to manufacture more nickel carbonyl, with a small bleed to waste to prevent a build-up of inert gases. This bleed gas must be incinerated to destroy the nickel carbonyl and carbon monoxide present. It must then be filtered to remove nickel dust.

Water: Provided that water scrubbers are not used to scrub exhaust gases, the process does not give rise to a water effluent.

Waste: The residue from the carbonyl extraction stage consists mainly of nickel oxide, but contains sufficient precious metals to warrant further processing. This material is not discarded but transferred for further processing.

Air: Nickel carbonyl is highly toxic and also a carcinogen.

Significant quantities of dusty raw materials are handled.

Energy: The carbonyl process is energy-efficient by virtue of the relatively low operating temperatures required.

Accidents: A major release of carbonyl could have serious health and environmental consequences.

Application Form Question 2.3 (cont.) — Nickel by the carbonyl process

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for nickel by the carbonyl process

1. Minimisation of carbonyl process inventory to minimise potential accident impact.
2. Back-up and redundancy in gas handling systems to minimise risk of leaks arising from breakdown.
3. Back-up power supplies for safety and environmentally critical items.
4. Effective incineration and filtration systems for handling waste gases.
5. Comprehensive gas leak detection systems.
6. An effective emergency control system with regular and realistic exercises.

Carbon & graphite

BREF Section 12

SI 1973 Sections 6.2 and 6.3

2.3.9 Carbon and graphite electrodes

Manufacture of carbon electrodes is included within this note because a major proportion of the installations where this activity is carried on are directly associated with installations defined within Section 2.2 Part A (1). This was recognised by the authors of the BREF Note, who included the manufacture of carbon and graphite electrodes within the Non-Ferrous Metals BREF.

Carbon electrodes and furnace linings are used for a variety of metal production processes, in particular primary aluminium smelting, making ferro alloys and steel-making.

The most frequently used raw materials are petroleum coke, anthracite, pitch and bitumen.

2.3.9.1 Manufacture of pre-baked carbon anodes for aluminium manufacture

BREF Section 12.1.1.2

SI 1973 Section 6.3 Part A (1) (a) (ii)

Process: Pre-baked electrodes for aluminium manufacture are manufactured from a mixture of petroleum coke with between 14 and 18% coal tar pitch to act as a binder.

The petroleum coke is first crushed, ground and graded to produce the range of particle sizes which on blending will generate a mixture of maximum density. Material recovered from used anodes is similarly treated and added to the blend prior to mixing with the molten pitch. This mixture is referred to as green electrode paste. After mixing “green” electrodes are formed by pressing then transferred to a ring furnace for baking.

The ring furnace consists of a series of refractory lined pits into which the anodes are stacked then covered with loose coke to prevent oxidation. Coke is also placed between the layers of anodes to prevent them from sticking together.

The flues and burners around the ring furnace are designed so that they can be rearranged on a regular basis. This permits direction of hot gases to groups of pits in sequence, and also allows newly charged pits to be warmed by exhaust gases from hotter pits. The system aids fuel economy and also allows for baked anodes to be removed and pits recharged whilst other pits are heating, soaking or cooling. The ducts are maintained at a negative pressure to avoid loss of fume into the air.

Water: Water use, mainly as a coolant in closed circuit systems, is not significant. Main risk arises from fire fighting water should a fire occur.

Waste: There is no planned waste production. Waste can arise during maintenance and as a consequence of production errors. It is normally possible to recycle production waste.

Air: All operations involving hot pitch are potential sources of fume.

All transfer operations of petroleum coke are potential sources of grit and dust emissions.

Pitch fume evolved during baking may not be completely burned before discharge through the chimney.

Inadequately cleaned returned butts have the potential to cause significant fluoride emissions through the bake furnace stack. This fluoride can also damage ring furnace refractories with the potential to cause loss of pitch fume.

There is also an important indirect effect: sulphur present in raw materials remains in the baked anode. When the anode is consumed in the associated aluminium works, this sulphur is discharged to air as sulphur dioxide.

Noise: Is not significant.

Energy: These processes are high energy users.

Accidents: Hot pitch represents a significant fire hazard.

Application Form Question 2.3 (cont.) → Pre-baked carbon anodes for aluminium manufacture

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

Indicative BAT requirements

BAT for carbon bake activities associated with aluminium processes

1. Minimise sulphur content of raw materials.
2. Effective cleaning of returned anode butts.
3. Planned maintenance cycles for the ring furnace refractory.
4. Effective fire prevention and response systems.
5. Treated ring furnace exhaust gases to remove fluorides before discharge into the air.

2.3.9.2 Manufacture of graphite electrodes

BREF Section 12.1.1.3

SI 1973 Section 6.2 Part A (1) (a)

Process: Manufacture of graphite electrodes is a two-stage process. The first stage is very similar to that used to manufacture pre-baked anodes, except that:

- recycled raw materials are not normally used, and
- furnaces other than ring furnaces may be used.

After baking at around 1100°C, the electrodes are allowed to cool, then impregnated with pitch before heating in the graphitising furnace to approximately 2800°C.

This temperature is achievable using electric resistance furnaces.

The carbon shapes are loaded into the furnace and buried with thermally insulating packing, usually coke or silicon carbide to prevent oxidation during the process. Heat is provided by passing electric current through the shape (Castner furnace) or through both shape and packing (Acheson furnace).

The heating cycle takes up to 7 days, with as many as 14 days to cool before the insulation can be removed.

After graphitisation, the shapes are finished by turning, drilling and milling according to the customer's requirements.

Dusts produced by these activities may be re-used in the blend, or used as insulation material.

The environmental comment relevant to anode bake furnaces apply, with the exception of those relating to use of fluoride contaminated recycle material.

Additional factor: Dust from machining activities.

2.3.9.3 Søderberg electrodes

BREF Section 12.1.1

There are two forms of Søderberg electrodes: pre-formed electrodes or paste. Both are self-baking electrodes.

Pre-formed electrodes are made from Søderberg paste which is pressed into cylindrical moulds . The cylinders are fed into the furnace through steel tubes which act as the electrical contact. The electrodes bake as they near the furnace and seal against the tubes, preventing the emission of baking gases. This type of electrode is used in a variety of electric arc furnaces.

Paste electrodes consist of a former suspended immediately above the furnace and are used exclusively for primary aluminium production. Green electrode paste (see Section 2.3.9.1 above) is charged into the former, where it is slowly hardened and baked by the heat of the furnace below. As the electrode is consumed from below, so more paste is added above. Electrical contact is achieved by conductor stubs driven into the sides of the electrode.

For aluminium electrolysis, the problems of pitch fume generation associated with Søderberg anodes are such that they are not regarded as BAT.

Carbon & graphite

2.3.9.4 Special carbon products

A range of products such as seals, brushes and crucibles are produced in a similar way to carbon and graphite electrodes.

Potential emissions are similar, as is BAT. However, certain special processes may be encountered.

(a) High-purity graphite manufacture

BREF Section 12.1.2

Process: As graphite manufacture, but modified to remove included impurities such as metals.

Freons are passed through the insulating carbon bed and decompose to generate chlorine and fluorine. These gases react with metallic impurities to form salts which are volatile at the operating temperature. The gases are condensed to remove undecomposed freons, then dry scrubbed to remove excess halogens and metal salts.

Water: Not significant.

Waste: Not significant.

Noise: Not significant.

Air: Loss of freon, dusts and acid gases.

Accidents: Not significant.

As this process involves the destruction of freons of the type recovered from refrigerators, it incidentally provides a useful method of disposal.

Application Form Question 2.3 (cont.) — High-purity graphite

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for this aspect of the activities.

BAT for high-purity graphite

Indicative BAT requirements

1. No additional requirement.

Abatement to air

2.3.10 Abatement of *point source* emissions to air

Sources

The nature and source of the emissions expected from each activity are given in previous sections and will be confirmed in detail in the Operator's response to Section 3.1.

In general they comprise the following:

- Primary exhausts from furnaces
- Collection hoods around charging doors, tap hole and launders
- Casting stations and flame cutting locations
- Raw material conveyor transfer points
- Storage tank and silo vents
- Ladle pre-heating stations
- Exhausts from slag coolers
- Exhausts from crushing, screening and grinding plant
- Exhausts from chemical processes.

Cross-sectoral guidance on abatement techniques for point source emissions to air can be found in Ref. 12.

Application Form Question 2.3 (cont.)

Control of point source emissions to air

BREF Sections 2.7, 2.8, 2.17

Subsections 4 of Chapters 3 to 12 describe the nature of the emissions and BAT for the Sectors

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for control and abatement equipment; and in addition

2. Describe the measures taken to demonstrate the reliable operation of control and abatement systems. These shall include as appropriate:
   - temperature and pressure monitors on filtration plant and associated ductwork
   - power consumption indicators on fans associated with extraction systems
   - temperature monitoring on exhausts from furnaces and after-burners
   - where wet scrubbing systems are used, liquor flowrate pH monitors.

3. Where VOCs are released, the identification of the main chemical constituents of the emissions and assessment of the fate of these chemicals in the environment. These steps will be carried out as in response to Sections 3.1 and 4.1 but need to be understood here in order to demonstrate that the controls are adequate.

Indicative BAT requirements

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

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

Cont.

Abatement to air

3. **Summary of sources of potential releases to air and the BAT treatment/abatement options**

Process stage	Component in off-gas	Treatment method
Materials handling and storage	Dust and metals	Correct storage, handling and transfer. Dust collection and fabric filter if necessary
Grinding, drying	Dust and metals	Process operation. Gas collection and fabric filter
Sintering/roasting, Smelting, Converting, fire refining	VOCs, dioxins	After-burner, adsorbent or activated carbon addition
	Dust and metal compounds	Gas collection, gas cleaning in fabric filter, heat recovery
	Carbon monoxide	After-burner if necessary
	Sulphur dioxide	Sulphuric acid plant (for sulphidic ores) or scrubber
Slag treatment	Dust and metals	Gas collection, cooling and fabric filter
	Sulphur dioxide	Scrubber
	Carbon monoxide	After-burner
Leaching and chemical refining	Chlorine	Gas collection and re-use, wet chemical scrubber
Carbonyl refining	Carbon monoxide, hydrogen	Sealed process, recovery and re-use. After-burner and dust removal in fabric filter for tail gas
Solvent extraction	VOC (depends on the solvent used and should be determined locally to assess the possible hazard)	Containment, gas collection, solvent recovery. Carbon adsorption if necessary
Thermal refining	Dust and metals	Gas collection and fabric filter
	Sulphur dioxide	Scrubber if necessary
Molten salt electrolysis	Fluoride, chlorine, PFCs	Process operation. Gas collection, scrubber (alumina) and fabric filter.
Electrode baking, graphitisation	Dust, metals, SO_2, fluoride, PAHs, tars	Gas collection, condenser and EP, after-burner or alumina scrubber and fabric filter. Scrubber if necessary for SO_2
Metal powder production	Dust and metals	Gas collection and fabric filter
	Dust, Ammonia	Gas collection and recovery. Acid medium scrubber
High-temperature reduction	Hydrogen	Sealed process, re-use
Electro-winning	Chlorine, acid mist	Gas collection and re-use, wet scrubber, de-mister
Melting and casting	Dust and metals	Gas collection and fabric filter
	VOCs, dioxins (organic feed)	After-burner (carbon injection)

Note: Ceramic filters may be used in preference to fabric filter where hot gases, or gases which may contain hot particles, are to be filtered. Hot electrostatic precipitators would be used in a gas cleaning system prior to a sulphuric acid plant or for wet gases.

Effluent treatment

2.3.11 Abatement of *point source* emissions to surface water and sewer

The nature and source of the emissions expected from each activity are given in previous sections and will be confirmed in detail in the Operator's response to Section 3.1. In general, waste-water can arise from the process activity, from storm water, from cooling water, from accidental emissions of raw materials, products or waste materials, and from fire fighting. In addition to the BREF and the techniques below, guidance on cost-effective effluent treatment techniques can be found in Envirowise Guides (Ref. 10).

The use of wet scrubbers to prevent or minimise emissions to air must be carefully reviewed and considered against the overall environmental impact of the activity. The presumption should be that if there are no pressing reasons to the contrary, then dry systems should be adopted, even where this leads to a marginal increase in emissions into the air.

Application Form Question 2.3 (cont.) → Effluent treatment

BREF Sections 2.9 and 2.17

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 to prevent or reduce point source emissions to water and land.
2. Include, where appropriate, off-site treatment in the description of the waste-water treatment system for the activity.
3. Provide, where effluent is discharged, a justification for not cleaning the effluent to a level at which it can be re-used (e.g. by ultrafiltration where appropriate).
4. Describe measures taken to increase the reliability with which the required control and abatement performance is delivered (the measures taken to ensure that any decline in quality of the effluent are promptly identified, e.g. continuous measurement, record and alarm systems associated with simple parameters such as temperature, pH or turbidity).
5. Identify the main chemical constituents of the treated effluent (including the make-up of the COD) and assessment of the fate of these chemicals in the environment. These steps will be carried out as in response to Sections 3.1 and 4.1 but need to be understood here in order to demonstrate that the controls are adequate. This applies whether treatment is on- or off-site.
6. Identify the toxicity of the treated effluent (see Section 2.10). Until the Regulator's toxicity guidance is available, this should, unless already in hand, normally be carried out as part of an improvement programme.
7. Where there are harmful substances or levels of residual toxicity, identify the causes of the toxicity and the techniques proposed to reduce the potential impacts.
8. Consider whether the effluent flow is sufficient to fall within the requirements of the Urban Waste Water Treatment Directive.

Indicative BAT requirements

1. The Operator should complete any detailed studies required into abatement or control options (see item 3 in Section 2.3) as an improvement condition to a timescale to be agreed with the Regulator but in any case within the timescale given in Section 1.1.
2. The following general principles should be applied in sequence to control emissions to water:
   - water use should be minimised and waste water re-used or recycled (see Section 2.2.3);
   - contamination risk of process or surface water should be minimised (see Section 2.3.13);
   - ultimately, surplus water is likely to need treatment to meet the requirements of BAT (and statutory and non-statutory objectives). Generally, effluent streams should be kept separate, as treatment will be more efficient. However, the properties of dissimilar waste streams should be used where possible to avoid adding further chemicals, e.g. neutralising waste acid and alkaline streams. Also, biological treatment can occasionally be inhibited by concentrated streams, while dilution, by mixing streams, can assist treatment;
   - systems should be engineered to avoid effluent by-passing the treatment plant.

Cont.

Effluent treatment

BREF Chapter 12.17.7

3. All emissions should be controlled, as a minimum, to avoid a breach of water quality standards (see Sections 3.2 and 4.1) but noting that where BAT can deliver prevention or reduction at reasonable cost it should do so (see Section 1.1). Calculations and/or modelling to demonstrate this will be carried out in response to Section 4.1. BAT for effluent treatment is the precipitation of metals using hydroxide, sulphide or a combination of these reagents.

4. BOD is not normally an issue in this sector but if it is present then the nature of the receiving water should be taken into account. However, in IPPC the prevention or reduction of BOD is also subject to BAT and further reductions which can be made at reasonable cost should be carried out. Furthermore, irrespective of the receiving water, the adequacy of the plant to minimise the emission of specific persistent harmful substances must also be considered. Guidance on treatment of persistent substances can be found in references (see Ref. 13).

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

6. **Summary of sources of potential releases to water and the BAT treatment options**

Source of waste water	Associated process	Minimisation methods	Treatment methods
Process water	Alumina production, lead–acid battery breaking, pickling	Return to process as far as possible	Neutralisation and precipitation, electrolysis
Indirect cooling water	Furnace cooling for most metals, electrolyte cooling for Zn	Use of sealed or air cooling system. System monitoring to detect leaks	Settlement
Direct cooling water	Al, Cu, Zn castings, carbon electrodes	Settlement, closed cooling system	Settlement, precipitation if needed
Slag granulation	Cu, Ni, Pb, Zn, precious metals, ferro alloys		Settlement, precipitation if needed
Electrolysis	Cu, Ni, Zn	Sealed system. Electro-winning of electrolyte bleed	Neutralisation and precipitation
Hydro-metallurgy (blow-down)	Zn, Cd	Sealed system	Settlement, precipitation if needed
Abatement system (blow-down)	Wet scrubbers, wet EPs and scrubbers for acid plants	Re-use of weak acid streams if possible	Settlement, precipitation if needed
Surface water	All	Good design of rain water collection and removal drains to prevent contamination. All raw materials, products and wastes with a potential to contaminate water to be stored under cover	Settlement, precipitation if needed, filtration

Fugitive emissions

2.3.12 Control of *fugitive* emissions to air

At most installations where non-ferrous metals processes are carried out, fugitive emissions to air give rise to a significant proportion of the overall environmental impact and should be reduced as far as practicable.

Potential sources of fugitive emissions to air which require particular attention are:

- handling and storage of dusty raw materials such as concentrates, foundry sand, drosses
- smelting and melting and refining furnaces and their associated extraction systems
- transfer operations involving molten metal
- casting and associated activities
- handling, storage and disposal of wastes such as drosses, slags and skimmings
- fume treatment plant, particularly handling collected dusts
- ladle heating stations.

Application Form Question 2.3 (cont.) → Fugitive emissions to air

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for control of fugitive emissions to air.

2. Identify and, where possible, quantify significant fugitive emissions to air from all relevant sources (including potential sources identified above). Estimate the proportion of total emissions which are attributable to fugitive releases for each substance. These steps will be carried out in response to Section 3.1 but need to be understood here in order to demonstrate that the controls are adequate.

Indicative BAT requirements

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

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

3. ***Dust and fume*** – The following general techniques should be employed where appropriate:
   - covering of skips and vessels
   - avoidance of outdoor or uncovered stockpiles
   - where outdoor stocking is unavoidable, use of sprays, binders, stockpile management techniques, windbreaks, etc.
   - wheel and road cleaning (avoiding transfer of pollution to water and wind blow)
   - closed conveyors, pneumatic conveying (noting the higher energy needs), minimising drops
   - regular housekeeping
   - sealing of furnaces and reactors
   - minimising open molten metal transfers
   - adequate extraction of process exhausts designed for the maximum rate of emission.

4. ***VOCs*** – The requirements of the Solvents Directive 1999/13/EC need to be complied with. When transferring fuel or other volatile liquids, the following techniques should be employed:
   - subsurface filling via filling pipes extended to the bottom of the container,
   - the use of vapour balance lines that transfer the vapour from the container being filled to the one being emptied, or
   - an enclosed system with extraction to suitable abatement plant.

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

6. ***Odour*** – See Section 2.3.14.

Fugitive emissions

2.3.13 Control of *fugitive* emissions to surface water, sewer and groundwater

Application Form Question 2.3 (cont.) → Fugitive emissions to water

BREF Sections 2.4, 2.9 and 2.17

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for control of fugitive emissions to air.
2. Identify and where possible quantify any significant fugitive emissions to water from all relevant sources, estimating the proportion of total emissions which are attributable to fugitive releases for each substance; these steps will be carried out as in response to Section 3.1 but need to be understood here in order to demonstrate that the controls are adequate.

Indicative BAT requirements

1. Where there are opportunities for reductions, the Permit may require the updated inventory of fugitive emissions to be submitted on a regular basis.
2. ***Subsurface structures – the Operator should:***
   - establish and record the routing of all installation drains and subsurface pipework;
   - identify all subsurface sumps and storage vessels;
   - engineer systems to ensure leakages from pipes, etc., are minimised and, where these occur, can be readily detected, particularly where hazardous (e.g. listed) substances are involved;
   - provide, in particular, secondary containment and/or leakage detection for such subsurface pipework, sumps and storage vessels;
   - establish an inspection and maintenance programme for all subsurface structures, e.g. pressure tests, leak tests, material thickness checks or CCTV.
3. ***Surfacing – the Operator should:***
   - describe the design (relevant information may include as appropriate: capacities; thicknesses; falls; material; permeability; strength/reinforcement; resistance to chemical attack; inspection and maintenance procedures; and quality assurance procedures) and condition of the surfacing of all operational areas;
   - have an inspection and maintenance programme of impervious surfaces and containment kerbs;
   - justify where operational areas have not been equipped with:
     - an impervious surface;
     - spill containment kerbs;
     - sealed construction joints;
     - connection to a sealed drainage system.
4. ***Bunds***
   All tanks containing liquids whose spillage could be harmful to the environment should be bunded. For further information on bund sizing and design, see Ref. 13. Bunds should:
   - be impermeable and resistant to the stored materials;
   - have no outlet (i.e. no drains or taps) and drain to a blind collection point;
   - have pipework routed within bunded areas with no penetration of contained surfaces;
   - be designed to catch leaks from tanks or fittings;
   - have a capacity which is the greater of 110% of the largest tank or 25% of the total tankage;
   - be subject to regular visual inspection and any contents pumped out or otherwise removed under manual control after checking for contamination;
   - where not frequently inspected, be fitted with a high-level probe and an alarm as appropriate;
   - have fill points within the bund where possible or otherwise provide adequate containment;
   - have a routine programmed inspection of bunds (normally visual but extending to water testing where structural integrity is in doubt).

2.3.14 Odour

Application Form Question 2.3 (cont.) → Odour control

BREF Section 2.14

With the application the Operator should:

1. Supply the general application requirements for Section 2.3 on page 29 for odour control. In addition, where odour could potentially be a problem, the Operator should:
2. ***Categorise the emissions as follows:***
   (a) ***A high level release which is expected to be acknowledged in the Permit*** – i.e. there will be an allowed release from the process (e.g. an odorous release from a stack or high-level scrubber) and an element of BAT is adequate dispersion between source and receptor to prevent odour nuisance. The release will be allowed under the Permit but it is acknowledged that, under certain conditions, the plume may ground causing odour problems. Conditions in Permits are likely to be based on the actions to take when such events occur.

   (b) ***Release should be preventable*** – i.e. releases can normally be contained within the site boundary by using BAT such as containment, good practice or odour abatement.

   (c) ***Release is not preventable under all circumstances*** – e.g. from a landfill or uncovered effluent treatment plant but potential problems are controlled by a programme of good practice measures.
3. For each relevant category, demonstrate that there will not be an odour problem from the emissions under normal conditions (see odour guidance).
4. For each relevant category, identify the actions to be taken in the event of abnormal events or conditions which might lead to odour, or potential odour problems (see odour guidance).
5. Describe the current or proposed position with regard to any techniques given below or in Ref. 25.

Indicative BAT requirements

1. The requirements for odour control will be sector-specific and dependent upon the sources and nature of the potential odour. In general terms:
   - where odour can be contained, for example within buildings, the Operator should ensure that the maintenance of the containment and the management of the operations are such as to prevent its release at all times;
   - where odour releases are permitted (see examples above):
     - for new installations or significant changes, the releases should be modelled to demonstrate a low frequency of ground-level concentrations above the odour threshold (or other threshold of acceptability). For occasions where weather conditions or other incidents are liable, in the view of the Regulator, to cause exceedances of the threshold of acceptability, the Operator should take appropriate and timely action, including shutting down the operations, to prevent further annoyance;
     - for existing installations, the same principle applies, except that where experience shows there to be no odour problem such modelling and actions will not be necessary.
2. For complex installations, for example where there are a number of potential sources of odorous releases or where there is an extensive programme of improvements to bring odour under control, an odour management plan should be maintained. The Regulator may incorporate the odour management plan in the Permit.

Groundwater

2.4 Emissions to groundwater

Groundwater protection legislation

The Groundwater Regulations (1998) came into force on 1 April 1999 (see Appendix 2 for equivalent legislation in Scotland and Northern Ireland). An IPPC Permit will be subject to the following requirements under these Regulations.

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

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

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

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

The principles, powers and responsibilities for groundwater protection in England and Wales, together with the Agency's policies in this regard, are outlined in the Environment Agency's document *Policy and Practice for the Protection of Groundwater* (PPPG) (see Ref. 26). This outlines the concepts of vulnerability and risk and the likely acceptability from the Agency's viewpoint of certain activities within groundwater protection zones.

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

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

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

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

Application Form Question 2.4

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

With the application the Operator should:

Meeting the requirements of the Groundwater Regulations

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

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

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

Cont.

Groundwater

List I and List II substances

List I

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

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

(b) organophosphorus compounds;

(c) organotin compounds;

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

(e) mercury and its compounds;

(f) cadmium and its compounds;

(g) mineral oils and hydrocarbons;

(h) cyanides.

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

List II

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

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

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

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

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

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

(e) inorganic compounds of phosphorus and elemental phosphorus;

(f) fluorides;

(g) ammonia and nitrites.

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

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

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

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

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

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

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

2.5 Waste handling

The normal nature and source of the waste from each activity is given in Section 2.3 and will be confirmed in detail in the Operator's response to Section 3.1. In general the waste streams comprise:

- furnace slags and drosses
- furnace maintenance waste such as insulation and refractory
- maintenance wastes, especially furnace wastes such as insulation, refractory and linings
- de-watered sludges from water treatment plant
- transport and packaging waste including drums.

Application Form Question 2.5

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

BAT for waste handling

BREF Sections 2.4, 2.10 and 2.17

With the application the Operator should:

1. Identify and quantify the waste streams including which wastes are covered by the Special Waste Regulations 1996 (SI 1996 No 9720).
2. Identify the current or proposed handling arrangements.
3. Describe the current or proposed position with regard to the techniques below or any others that are pertinent to the installation.
4. Demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the *Guide for Applicants*) or alternative measures.

Indicative BAT requirements

1. A system should be maintained to record the quantity, nature, origin and, where relevant, the destination, frequency of collection, mode of transport and treatment method of any waste which is disposed of or recovered.
2. Wherever practicable, waste should be segregated and the disposal route identified which should be as close to the point of production as possible.
3. Records should be maintained of any waste that is sent off-site (Duty of Care).
4. Storage areas should be located away from watercourses and sensitive boundaries, e.g. adjacent to areas of public use, and protected against vandalism.
5. Storage areas should be clearly marked and signed and containers should be clearly labelled.
6. The maximum storage capacity of storage areas should be stated and not exceeded. The maximum storage period for containers should be specified.
7. Appropriate storage facilities should be provided for special requirements such as for substances that are flammable, sensitive to heat or light, etc., and incompatible waste types should be kept separate.
8. Containers should be stored with lids, caps and valves secured and in place. This also applies to emptied containers.
9. Storage containers, drums, etc., should be regularly inspected.
10. Procedures should be in place to deal with damaged or leaking containers.
11. Materials such as drosses, which may dissolve or react with water, shall only be stored under cover.
12. All appropriate steps to prevent emissions (e.g. liquids, dust, VOCs and odour) from storage or handling should be taken (see Sections 2.3.12, 2.3.13 and 2.3.14).

Waste

2.6 Waste recovery or disposal

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

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

Application Form Question 2.6

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

BAT for waste disposal or recovery

BREF Section 2.10

With the application the Operator should:

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

Indicative BAT requirements

1. Unless agreed with the Regulator to be inappropriate, the Operator should provide a detailed assessment identifying the best practicable environmental options for waste disposal. For existing activities, this may be carried out as an improvement condition to a timescale to be approved by the Regulator.

Cont.

2. **Overview of residues and available BAT options for dealing with them**

Source of the residues	Associated metals	Residue	Possible options for dealing with them
Raw materials handling, etc.	All metals	Dust, sweepings	Feed for the main process
Smelting furnace	All metals	Slag	Construction material after slag treatment. Abrasive industry. Parts of slag may be used as refractory material, e.g. slag from the production of chromium metal
	Ferro alloys	Rich slag	Raw material for other ferro alloy processes
Converting furnace	Cu	Slag	Recycle to smelter
Refining furnaces	Cu	Slag	Recycle to smelter
	Pb	Skimmings	Recovery of other valuable metals
	Precious metals (PMs)	Skimmings and slag	Internal recycle
Slag treatment	Cu and Ni	Cleaned slag	Construction material. Matte produced
Melting furnace	All metals	Skimmings	Return to process after treatment
		Slag and salt slag	Metal recovery, recovery of salt and other material
Electro-refining	Cu	Electrolyte bleed	Recovery of Ni
		Anode remnants	Return to converter
		Anode slime	Recovery of precious metals
Electro-winning	Zn, Ni, Co, PMs	Spent electrolyte	Re-use in leaching process
Fused salt electrolysis	Al	Spent pot lining	Carburant or disposal
		Excess bath	Sale as electrolyte
		Anode stubs	Recovery
	Na and Li	Cell material	Scrap iron after cleaning
Distillation	Hg	Residues (hollines)	Re-use as process feed
	Zn, Cd	Residues	Return to process
Leaching	Zn	Ferrite residues	Safe disposal, re-use of liquor
	Cu	Residues	Safe disposal
	Ni/Co	Cu/Fe residues	Recovery, disposal
Sulphuric acid plant	Primary Cu, Pb, Zn	Catalyst	Regeneration
		Acid sludges	Safe disposal
		Weak acid	Leaching, disposal
Furnace linings	All metals	Refractory	Crush, for possible recovery of metallic inclusions. May require treatment to minimise potential hazards before final disposal
Milling, grinding	Carbon	Carbon and graphite dusts	Use as raw material in other processes
Pickling	Cu, Ti	Spent acid	Recovery
Dry abatement systems	Most – using fabric filters or EPs	Filter dust	Return to process, recovery of other metals, disposal
Wet abatement systems	Processes using scrubbers or wet EPs	Filter sludge	Return to process, recovery of other metals, disposal
Waste water treatment sludge	Most	Hydroxide or sulphide sludges	Safe disposal, re-use

2.7 Energy

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

either

- the Operator meets the basic energy requirements in Sections 2.7.1 and 2.7.2 below and is a participant to a Climate Change Agreement (CCA) or Trading Agreement with the Government

or

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

Note that, even where a Climate Change Agreement or Trading Agreement is in place, it does not preclude the consideration of energy efficiency techniques (including those identified in Section 2.7.3) as part of an integrated assessment of BAT where they impact on other emissions, e.g. where:

- the choice of fuel impacts upon emissions other than carbon, e.g. sulphur in fuel;
- the minimisation of waste by waste-to-energy does not maximise energy efficiency, e.g. by CHP;
- the most energy-intensive abatement leads to the greatest reduction in other emissions.

Further guidance is given in the Energy Efficiency Guidance Note (Ref. 15).

2.7.1 Basic energy requirements (1)

Application Form
Question 2.7 (part 1)

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

The requirements of this section are basic, low-cost, energy standards which apply whether or not a Climate Change Agreement or Trading Agreement is in place for the installation.

With the application the Operator should:

1. Provide energy consumption information in terms of delivered energy and also, in the case of electricity, converted to primary energy consumption. For the public electricity supply, a conversion factor of 2.6 should be used. Where applicable, the use of factors derived from on-site heat and/or power generation, or from direct (non-grid) suppliers should be used. In the latter cases, the Applicant should provide details of such factors. Where energy is exported from the installation, the Applicant should also provide this information. An example of the format in which this information should be presented is given in Table 2.7.1 below. The Operator should also supplement this information with energy flow diagrams (such as energy balances or "Sankey" diagrams, as appropriate) showing how the energy is used throughout the process.

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

Table 2.7.1 - Example breakdown of delivered and primary energy consumption

Energy source	Energy consumption		
	Delivered, MWh	Primary, MWh	% of total
Electricity from public supply			
Electricity from other source*			
Imported steam/hot water*			
Gas		N/A	
Oil		N/A	
Coal		N/A	
Other (Operator to specify)			

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

3. Provide associated environmental emissions. This is dealt with in the Operator's response to Section 3 of this guidance.

2.7.2 Basic energy requirements (2)

Application Form Question 2.7 (part 2)

Describe the proposed measures for improvement of energy efficiency.

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

With the application the Operator should:

1. Describe the current or proposed position with regard to the basic, low–cost energy requirements below, and provide justifications for not using any of the techniques described.
2. Provide an energy efficiency plan that appraises different energy options as described below.

Basic energy requirements

1. *Operating, maintenance and housekeeping measures* should be in place in the following areas. Indicative checklists of appropriate measures are provided in Appendix 2 of the *IPPC Energy Efficiency Guidance Note*, where relevant:
   - air conditioning, process refrigeration and cooling systems (leaks, seals, temperature control, evaporator/condenser maintenance);
   - operation of motors and drives;
   - compressed gas systems (leaks, procedures for use);
   - steam distribution systems (leaks, traps, insulation);
   - space heating and hot–water systems;
   - lubrication to avoid high–friction losses;
   - boiler maintenance, for example, optimising excess air;
   - other maintenance relevant to the activities within the installation.
2. *Basic, low cost, physical techniques* should be in place to avoid gross inefficiencies. These should include insulation, containment methods (such as seals and self-closing doors), and avoidance of unnecessary discharge of heated water or air (for example, by fitting simple control systems such as timers and sensors).
3. *Energy efficiency Building services* should be in place to deliver the requirements of the Building Services section of the *Energy Efficiency Guidance Note*. For energy-intensive industries these issues may be of minor impact and should not distract effort from the major energy issues. They should nonetheless find a place in the programme, particularly where they constitute more than 5 percent of the total energy consumption.
4. *Energy management techniques* should be in place, according to the requirements of Section 2.1 noting, in particular, the need for monitoring of energy flows and targeting of areas for reductions.
5. *An energy efficiency plan* should be provided that:
   - identifies all techniques relevant to the installation, including those listed above and in Section 2.7.3, that are applicable to the installation;
   - estimates the CO2 savings that would be achieved by each measure over its lifetime;

   and, **in the case where the activities are NOT covered by a CCA or Trading Agreement;**
   - provides information on the equivalent annual costs of implementation of the technique, the costs per tonne of CO2 saved and the priority for implementation. A procedure is given in the *Energy Efficiency Guidance Note*.

   An example format of the energy efficiency plan is shown overleaf.

Table 2.7.2 Example format for energy efficiency plan

ALL APPLICANTS			ONLY APPLICANTS WITHOUT CCA		
Energy efficiency measure	CO_2 savings (tonnes)		Equivalent Annual Cost (EAC)[1] £k	EAC/CO_2 saved £/tonne	Date for implementation
	Annual	lifetime			

Notes

1. Refer to Energy Efficiency Guidance Note for appraisal methodology. Where other appraisal methodologies have been used, state the method, and provide evidence that appropriate discount rates, asset life and expenditure (£/t) criteria have been employed

The energy efficiency plan is required to ensure that the Operator has considered all relevant techniques. However, where a CCA is in place the Regulator will only enforce implementation of those measures in categories 1-3 above.

2.7.3 Sector-specific energy requirements

Application Form
Question 2.7 (part 3)

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

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

With the application the Operator should:

1. Identify which of the measures below are applicable to the activities, and include them in the appraisal for the energy efficiency plan in Section 2.7.2.

2. Describe the current or proposed position with regard to the techniques below, or any others which are pertinent to the installation.

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

BAT for energy (cont.)

BREF Section 2.11

Indicative BAT requirements

The following techniques should be implemented where they meet the financial criteria in Appendix 4 of the Energy Efficiency Guidance Note (Ref. 15).

1. **Energy efficiency techniques**

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

   Energy recovery before or after abatement is applicable in the majority of cases but local circumstances are important, for example, where there is no outlet for the recovered energy. The BREF Sections 2 in Chapters 3 to 12 give the current range of energy use for the various processes. BAT conclusions for energy use are not given as the raw materials available have a very strong influence on the energy use. BAT conclusions for the principles of energy recovery are given in Chapter 2. They are:

   - Production of steam and electricity from the heat raised in waste heat boilers.
   - The use of the heat of reaction to smelt or roast concentrates or melt scrap metals in a converter.

Cont.

- The use of hot process gases to dry feed materials.
- Pre-heating of a furnace charge using the energy content of furnace gases or hot gases from another source.
- The use of recuperative burners or the pre-heating of combustion air.
- The use as a fuel gas of CO produced.
- The heating of leach liquors from hot process gases or liquors.
- The use of plastic contents in some raw materials as a fuel, provided that good quality plastic cannot be recovered and VOCs and dioxins are not emitted.
- The use of low-mass refractories where practicable.
- The use of oxygen is recognised to have advantages in many cases and reduces the overall gas volume, allows autogenic operation and can allow smaller abatement plant.
- Process optimisation to minimise hot metal transfers.

Further information will be found in both the existing sector guidance and in the Energy Efficiency Guidance Note (Ref. 15).

2. **Energy supply techniques**

- Use of CHP.
- Use of less polluting fuels.

Irrespective of whether a Climate Change Agreement or Trading Agreement is in place, where there are other BAT considerations involved, such as:

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

the Operator should provide justification that the proposed or current situation represents BAT.

Where there is an on-site combustion plant other guidance is also relevant. For plants greater than 50 MW, Operators should consult the IPPC Guidance on power generation (reference IPC S2 1.01 and supplement IPC S3 1.01) and the operators of plant of 20–50 MW should consult the Local Authority Air Pollution Control Guidance. On IPPC installations this Guidance will be generally applicable to plant under 20 MW also. For incineration plant IPC S2 5.01 Waste Incineration should be consulted.

2.8 Accidents and their consequences

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

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

The COMAH regime applies to major hazards. For accident aspects covered by COMAH, reference should be made to any reports already held by the Regulator. However, the accident provisions under IPPC may fall beneath the threshold for major accident classification under COMAH and therefore consideration should be given to smaller accidents and incidents as well. Guidance (see Ref. 20) prepared in support of the COMAH Regulations may also be of help to IPPC Operators (whether or not they are covered by the COMAH regime) in considering ways to reduce the risks and consequences of accident.

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

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

Application Form Question 2.8	***Describe your documented system proposed to be used to identify, assess and minimise the environmental risks and hazards of accidents and their consequences.***

With the application the Operator should:

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

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

3. Identify any issues which may be critical.

Indicative BAT requirements

BAT for control of accidents

BREF Section 2.15

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

   (a) ***Identify the hazards*** to the environment posed by the installation. Particular areas to consider may include, but should not be limited to, the following:
   - transfer of substances (e.g. loading or unloading from or to vessels)
   - overfilling of vessels
   - failure of plant or equipment (including failure of electrical power supplies and failure of process control equipment)
   - failure of containment (e.g. bund and/or overfilling of drainage sumps)
   - failure to contain fire waters
   - making the wrong connections in drains or other systems
   - preventing incompatible substances coming into contact
   - unwanted reactions and/or runaway reactions
   - emission of an effluent before adequate checking of its composition has taken place
   - steam main issues
   - vandalism
   - charging unsuitable materials into furnaces, e.g. sealed containers, munitions.

Cont.

BAT for control of accidents (cont.)

(b) Assess the risks – having identified the hazards, the process of assessing the risks can be viewed as addressing six basic questions:

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

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

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

(c) Identify the techniques necessary to reduce the risks including:

(i) The following techniques, which are relevant to most installations.
An inventory should be maintained of substances, present or likely to be present, which could have environmental consequences if they escape. It should not be forgotten that many apparently innocuous substances can be environmentally damaging if they escape (e.g. a tanker of milk spilled into a watercourse could destroy its ecosystem). The Permit will require the Regulator to be notified of any changes to the inventory:

- procedures should be in place for checking raw materials and wastes to ensure compatibility with other substances with which they may accidentally come into contact;
- adequate storage arrangements for raw materials, products and wastes should be provided;
- to ensure that control is maintained in emergency situations, consideration should be given to process design alarms, trips and other control aspects, e.g. automatic systems based on microprocessor control and passing valve control, tank level readings such as ultrasonic gauges, high-level warnings and process interlocks and process parameters;
- preventive techniques, such as suitable barriers to prevent damage to equipment from the movement of vehicles, should be included as appropriate;
- appropriate containment should be provided, e.g. bunds and catchpots, building containment;
- techniques and procedures should be implemented to prevent overfilling of storage tanks (liquid or powder), e.g. level measurement, independent high-level alarms, high-level cut-off, and batch metering;
- installation security systems to prevent unauthorised access should be provided as appropriate and should include maintenance arrangements where necessary;
- there should be an installation log/diary to record all incidents, near-misses, changes to procedures, abnormal events and findings of maintenance inspections;
- procedures should be established to identify, respond to and learn from such incidents;
- the roles and responsibilities of personnel involved in accident management should be identified;

Cont.

Accidents

BAT for control of accidents (cont.)

- clear guidance should be available on how each accident scenario should be managed, e.g. containment or dispersion, to extinguish fires or let them burn;
- procedures should be in place to avoid incidents occurring as a result of poor communication among operations staff during shift changes and maintenance or other engineering work;
- safe shut-down procedures should be in place;
- communication routes should be established with relevant authorities and emergency services both before and in the event of an accident. Post-accident procedures should include the assessment of harm caused and steps needed to redress this;
- appropriate control techniques should be in place to limit the consequences of an accident, such as oil spillage equipment, isolation of drains, alerting of relevant authorities and evacuation procedures;
- personnel training requirements should be identified and provided;
- the systems for the prevention of fugitive emissions are generally relevant (Sections 2.3.12 and 2.3.13) and, in addition, for drainage systems:
  - procedures should be in place to ensure that the composition of the contents of a bund sump, or sump connected to a drainage system, are checked before treatment or disposal;
  - drainage sumps should be equipped with a high-level alarm or sensor with automatic pump to storage (not to discharge); there should be a system in place to ensure that sump levels are kept to a minimum at all times;
  - high-level alarms, etc., should not be routinely used as the primary method of level control.

(ii) The following plus any other specific techniques identified as necessary to minimise the risks as identified in 1 and 2 above.

- adequate redundancy or stand-by plant should be provided with maintenance and testing to the same standards as the main plant;
- process waters, site drainage waters, emergency fire water, chemically contaminated waters and spillages of chemicals should, where appropriate, be contained and, where necessary, routed to the effluent system, with provision to contain surges and storm-water flows, and treated before emission to controlled waters or sewer. Sufficient storage should be provided to ensure that this could be achieved. There should also be spill contingency procedures to minimise the risk of accidental emission of raw materials, products and waste materials and to prevent their entry into water. Any emergency fire water collection system should also take account of the additional fire water flows or fire fighting foams. Emergency storage lagoons may be needed to prevent contaminated fire water reaching controlled waters (see Refs. 16 and 17);
- consideration should be given to the possibility of containment or abatement for accidental emissions from vents and safety relief valves/bursting discs. Where this may be inadvisable on safety grounds, attention should be focused on reducing the probability of the emission;
- other techniques as identified in existing sector guidance.

Noise and vibration

2.9 Noise and vibration

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

The PPC Regulations require installations to be operated in such a way that "all the appropriate preventative measures are taken against pollution, in particular through the application of BAT". The definition of pollution includes "emissions which may be harmful to human health or the quality of the environment, cause offence to human senses or impair or interfere with amenities and other legitimate uses of the environment". BAT is therefore likely to be similar, in practice, to the requirements of the statutory nuisance legislation, which requires the use of "best practicable means" to prevent or minimise noise nuisance.

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

For advice on how noise and/or vibration related limits and conditions will be determined see *IPPC Noise – Part 1 Regulation and Permitting* (see Ref. 21).

Application Form
Question 2.9

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

Information needed to determine BAT for noise and vibration

With the application the Operator should:

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

   A common-sense approach needs to be adopted in determining which sources to include. The ones which need to be considered are those which may have environmental nuisance impact; e.g. a small unit could cause an occupational noise issue in an enclosed space but would be unlikely to cause an environmental issue. Conversely a large unit or a number of smaller units enclosed within a building could, for example, cause a nuisance if doors are left open. It must also be remembered that noise, which is not particularly noticeable during the day, may become more noticeable at night.

2. Provide the information required in (1) for each ***infrequent source of noise and vibration*** not listed above, that falls within the IPPC installation plus its times of operation (this includes infrequently operated/seasonal operations, cleaning/maintenance activities, on-site deliveries/collections/transport or out-of-hours activities, emergency generators or pumps and alarm testing).

3. Identify ***the nearest noise-sensitive sites*** (typically dwellings, parkland and open spaces – schools, hospitals and commercial premises *may* be, depending upon the activities undertaken there) and any other points/boundary where conditions have been applied by Local Authority officers or as part of a planning consent, relating to:

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

   (b) conditions/limits imposed which relate to other locations (i.e. boundary fence or surrogate for nearest sensitive receptor):
   - any planning conditions imposed by the Local Authority (day/evening/night);
   - other conditions imposed by agreements, e.g. limits on operating times, technologies, etc.;
   - any requirements of any legal notices, etc.

Cont.

Noise and vibration

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

(c) the noise environment:

- background noise level, if known (day/night/evening) $L_{A90,T}$;
- specific noise level (day/evening/night) $L_{Aeq,T}$; and/or
- ambient noise level (day/evening/night) $L_{Aeq,T}$, as appropriate;
- vibration data which may be expressed in terms of the peak particle velocity (ppv) in mm s^{-1} or the vibration dose value (VDV) in m $s^{-1.75}$.

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

4. Provide ***details of any environmental noise measurement surveys,*** modelling or any other noise measurements undertaken relevant to the environmental impact of the site, identifying:
   - the purpose/context of the survey
   - the locations where measurements were taken
   - the source(s) investigated or identified
   - the outcomes.
5. Identify any specific local issues and proposals for improvements.
6. Describe the current or proposed position with regard to the techniques below, any in Ref. 21 or any others which are pertinent to the installation.
7. Demonstrate that the proposals are BAT, by confirming compliance with the indicative requirements, by justifying departures (as described in Section 1.2 and in the Guide for Applicants) or alternative measures.

Indicative BAT requirements

1. The Operator should employ basic good practice measures for the control of noise, including adequate maintenance of any parts of plant or equipment whose deterioration may give rise to increases in noise (e.g. maintenance of bearings, air handling plant, the building fabric as well as specific noise attenuation measures associated with plant, equipment or machinery).
2. In addition the Operator should employ such other noise control techniques to ensure that the noise from the installation does not give rise to reasonable cause for annoyance, in the view of the Regulator and, in particular, should justify where either rating levels ($L_{Aeq,T}$) from the installation exceed the numerical value of the background sound level ($L_{A90,T}$), or the absolute levels of 50 dB L_{Aeq} by day or 45 by night are exceeded. Reasons why these levels may be exceeded in certain circumstances are given in Ref. 21.
3. In some circumstances "creeping background" (see Ref. 21) may be an issue. Where this has been identified in pre-application discussions or in previous discussions with the local authority, the Operator should employ such noise control techniques as are considered to be appropriate to minimise problems of noise to an acceptable level within the BAT criteria.
4. Noise surveys, measurement, investigation (which can involve detailed assessment of sound power levels for individual items of plant) or modelling may be necessary for either new or existing installations depending upon the potential for noise problems. Operators may have a noise management plan as part of their management system. More information on such techniques is given in Part 2 of Ref. 21.

2.10 Monitoring

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

Application Form Question 2.10

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

BREF Section 2.2

With the application the Operator should:

1. Describe the current or proposed position with regard to the monitoring requirements below or any others which are pertinent to the installation for "Emissions monitoring", "Environmental monitoring", "Process monitoring" (where environmentally relevant) and "Monitoring standards" employed.
2. Provide, in particular, the information described in requirement 17 below.
3. Provide justifications for not using any of the monitoring requirements described.
4. Identify shortfalls in the above information which the Operator believes require longer-term studies to establish.

Emissions monitoring

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

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

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

Monitoring and reporting of emissions to water and sewer

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

Parameter	Monitoring frequency
Flowrate	Continuous and integrated daily flowrate
pH	Continuous
Temperature	Continuous
COD/BOD	Flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages
Turbidity	Continuous
Metals which are likely to be released from the activity	Flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages

2. Monitoring of process effluents released to sewer should include at least:

Parameter	Monitoring frequency
Flowrate	Continuous (using a flow proportional sampler to create a 24 h composite sample which is analysed daily against trade effluent consent) and integrated daily flowrate
pH	Continuous
Temperature	Dependent on process; if process may generate an effluent > 25^{o}C, continuous monitoring would be appropriate
COD/BOD	Flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages
TOC	Dependent on process, see "Monitoring of Process Variables"

Cont.

Monitoring

NB – other parameters specifically limited in the Permit should be monitored. The appropriateness of the above frequencies will vary depending upon the sensitivity of the receiving water and should be proportionate to the scale of the operations.

3. In addition, the Operator should have a fuller analysis carried out covering a broad spectrum of substances to establish that all relevant substances have been taken into account when setting the release limits. This should cover the substances listed in Schedule 5 of the Regulations unless it is agreed with the Regulator that they are not applicable. This should normally be done at least annually.
4. Any substances found to be of concern, or any other individual substances to which the local environment may be susceptible and upon which the operations may impact, should also be monitored more regularly. This would particularly apply to the common pesticides and heavy metals. Using composite samples is the technique most likely to be appropriate where the concentration does not vary excessively.
5. In some sectors there may be releases of substances which are more difficult to measure and whose capacity for harm is uncertain, particularly when in combination with other substances. "Whole effluent toxicity" monitoring techniques can therefore be appropriate to provide direct measurements of harm, e.g. direct toxicity assessment. Some guidance on toxicity testing is available (Ref. 22) and the Regulator will be providing further guidance in due course. Except in special circumstances toxicity testing should await that guidance.

Monitoring and reporting of emissions to air

There is a wide variety of possible releases to air, and specific information may be found in Sections 2.3.1 to 2.3.9.

6. Continuous monitoring and recording are likely to be required under the following circumstances:
    - Where the potential environmental impact is significant or the concentration of the substance varies widely.
    - Where a substance is abated, continuous monitoring of the substance is required to show the performance of the abatement plant. For example, continuous monitoring of dust is needed after a fabric filter to show the effectiveness of the filter and indicate when maintenance is needed.
    - Where other control measures are required to achieve satisfactory levels of emission (e.g. charge selection, degreasing).
7. Gas flow should be measured, or otherwise determined, to relate concentrations to mass releases.
8. To relate measurements to reference conditions it will be necessary to measure and record the temperature and pressure of the emission. The water vapour content must also be measured if it is likely to exceed 3%, unless the measuring techniques used for other pollutants provide results on a dry basis.
9. Where appropriate, periodic visual and olfactory assessment of releases should be undertaken to ensure that all final releases to air should be essentially colourless, free from persistent trailing mist or fume and free from droplets.

Cont.

Monitoring

Emissions monitoring (cont.)

The following table indicates the likely monitoring frequencies for releases to air in this sector:

Substance	Availability of methods for	
	Continuous	Extractive
SO_2	Y	Y
NO_x	Y	Y
Particulate	Y	Y
VOC	Y	Y
HCl	Y	Y
HF		Y
Metals		Y
Dioxins & furans		Y
CO	Y	Y

Monitoring and reporting of waste emissions

10. For waste emissions the following should be monitored and recorded:
    - the physical and chemical composition of the waste;
    - its hazard characteristics;
    - handling precautions and substances with which it cannot be mixed;
    - where waste is disposed of directly to land, for example sludge spreading or an on-site landfill, a programme of monitoring should be established that takes into account the materials, potential contaminants and potential pathways from the land to groundwater, surface water or the food chain.

Environmental monitoring (beyond the installation)

Environmental monitoring

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

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

13. **The need should be considered for:**
    - groundwater, where it should be designed to characterise both quality and flow and take into account short- and long-term variations in both. Monitoring will need to take place both up-gradient and down-gradient of the site;

Environmental monitoring (cont.)

    - surface water, where consideration will be needed for sampling, analysis and reporting for upstream and downstream quality of the controlled water;
    - air, including odour;
    - land contamination, including vegetation, and agricultural products;
    - assessment of health impacts;
    - noise.

Cont.

Monitoring

14. **Where environmental monitoring is needed the following should be considered in drawing up proposals**:
    - determinands to be monitored, standard reference methods, sampling protocols;
    - monitoring strategy, selection of monitoring points, optimisation of monitoring approach;
    - determination of background levels contributed by other sources;
    - uncertainty for the employed methodologies and the resultant overall uncertainty of measurement;
    - quality assurance (QA) and quality control (QC) protocols, equipment calibration and maintenance, sample storage and chain of custody/audit trail;
    - reporting procedures, data storage, interpretation and review of results, reporting format for the provision of information for the Regulator.

    Guidance on air quality monitoring strategies and methodologies can be found in Technical Guidance Notes M8 and M9 (see Ref. 22), for noise (see Ref. 21) and for odour (see Ref. 25).

Monitoring of process variables

Monitoring process variables

BREF Chapter 2.17.2

15. Some process variables will have potential environmental impact and these should be identified and monitored as appropriate. Examples might be:
    - raw materials monitoring for contaminants where contaminants are likely and there is inadequate supplier information (see Section 2.2.1);
    - oxygen, carbon monoxide, pressure or temperature in the furnace atmosphere or off-gases;
    - plant efficiency where it has an environmental relevance;
    - energy consumption across the plant and at individual points of use in accordance with the energy plan. Frequency – normally continuous and recorded;
    - fresh water use across the activities and at individual points of use should be monitored as part of the water efficiency plan (see Section 2.2.3). Frequency – continuous and recorded;
    - the quantity of each class of waste generated.

Monitoring standards (Standard Reference Methods)

Equipment standards

Equipment standards MCERTS

The Environment Agency has introduced its Monitoring Certification Scheme (MCERTS) to improve the quality of monitoring data and to ensure that the instrumentation and methodologies employed for monitoring are fit for purpose. Performance standards have been published for continuous emissions monitoring systems (CEMs). Other MCERTS standards are under development to cover manual stack emissions monitoring, portable emissions monitoring equipment, ambient air quality monitors, water monitoring instrumentation, data acquisition and Operators' own arrangements, such as for installation, calibration and maintenance of monitoring equipment, position of sampling ports and provision of safe access for manual stack monitoring.

16. As far as possible, Operators should ensure their monitoring arrangements comply with the requirements of MCERTS where available, e.g. using certified instruments and equipment, and using a registered stack testing organisation etc. Where the monitoring arrangements are not in accordance with MCERTS requirements, the Operator should provide justification and describe the monitoring provisions in detail. See Environment Agency Website (Ref. 22) for listing of MCERTS equipment.

Cont.

Monitoring standards (cont.)

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

Standards for sampling and analysis

BREF: Monitoring REF document in preparation

Sampling and analysis standards

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

Further guidance on standards for monitoring gaseous releases relevant to IPC/IPPC is given in the Technical Guidance Note 4 (Monitoring) (see Ref. 22). A series of updated Guidance Notes covering this subject is currently in preparation. This Guidance specifies manual methods of sampling and analysis which will also be suitable for calibration of continuous emission monitoring instruments. Further guidance relevant to water and waste is available from the publications of the Standing Committee of Analysts.

If in doubt the Operator should consult the Regulator.

2.11 Decommissioning

The IPPC application requires the preparation of a site report whose purpose, as described in more detail in Refs. 5 and 6 is to provide a point of reference against which later determinations can be made of whether there has been any deterioration of the site and information on the vulnerability of the site.

Application Form
Question 2.11

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

BAT for decommissioning

BREF Section 2.16

With the application the Operator should:

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

Indicative BAT requirements

1. **Operations during the IPPC Permit**

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

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

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

Cont.

BAT for decommissioning (cont.)

- methods of dismantling buildings and other structures, see Ref. 26 which gives guidance on the protection of surface and groundwater at construction and demolition sites;
- testing of the soil to ascertain the degree of any pollution caused by the activities and the need for any remediation to return the site to a satisfactory state as defined by the initial site report.

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

For existing activities, the site closure plan may, if agreed with the Regulator, be submitted as an improvement condition.

2.12 Installation-wide issues

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

Application Form Question 2.12

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

With the application the Operator should:

1. Where there are a number of separate Permits for the installation (particularly where there are different operators), identify any installation-wide issues and opportunities for further interactions between the Permit-holders whereby the performance of the overall installation may be improved.

   In particular:

2. Describe the current or proposed position with regard to the techniques below, or any others which are pertinent to the installation.

BAT across the whole installation

BREF Section 2.12

Indicative BAT Requirements

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

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

3 EMISSION BENCHMARKS

3.1 Emissions inventory and benchmark comparison

Application Form Question 3.1

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

With the application the Operator should:

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

   The response should clearly state whether the emissions are current emission rates or those planned following improvements, and should cover emissions under both normal and abnormal conditions for:

   - point source emissions to surface water, groundwater and sewer;
   - waste emissions (refer to Sections 2.5 and 2.6 – waste management);
   - point source emissions to air;
   - significant fugitive emissions to all media, identifying the proportion of each substance released which is due to fugitives rather than point source releases;
   - abnormal emissions from emergency relief vents, flares, etc.;
   - indirect and direct emission of carbon dioxide associated with energy consumed or generated.

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

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

   For waste, emissions relate to any wastes removed from the installation, or disposed of at the installation under the conditions of the Permit, e.g. landfill. Each waste should have its composition determined and the amounts expressed in terms of cubic metres or tonnes per month.

   A suitable table on which to record this information is provided in the electronic version of this Guidance Note.

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

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

3.2 The emission benchmarks

Guidance is given below on the release concentrations or removal efficiencies achievable when using the best combination of techniques. These benchmark values represent the performance associated with the use of BAT. They are not mandatory release limits and reference should be made to the "Guide for Applicants", to Section 1 above, and to Sections 3.2.1 and 3.2.2 below as to their application.

Limits should be identified in Permits for all pollutants which are likely to be present in emissions in significant quantities whether or not the pollutants are identified in the lists below.

3.2.1 Emissions to air associated with the use of BAT

The emissions quoted below are daily averages based upon continuous monitoring during the period of operation. Standard conditions of 273 K and 101.3 kPa for the dry gas apply. No correction is applied for the oxygen content of the emission. Care should always be taken to convert benchmark and proposed releases to the same reference conditions for comparison. To convert measured values to reference conditions, see Technical Guidance Note M2 (Ref. 22) for more information

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

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

Where emissions are expressed in terms of concentrations and where continuous monitors are employed, it is recommended that limits are defined in accordance with the table in Section 3.2.1.1 below.

Metals and metal compounds are reported as the element.

3.2.1.1 *General requirements applicable to most installations*

Emission	Benchmark level As monthly average or from an extractive sample	Maximum allowed daily average when continuous monitoring is used provided monthly value is met	Techniques which may be considered to be BAT	Comment
Total particulate [a]	5mg/Nm^3	10 mg/Nm^3	Fabric filters. Wet scrubber for suitable types of dust	For some high-temperature processes ceramic filters may be BAT
Oxides of nitrogen [b] (as NO_2)	100 mg/Nm^3	200 mg/Nm^3	Low NOx burner	Oxy fuel burner gives reduced gas volume and better energy efficiency
	300 mg/Nm^3	500 mg/Nm^3	Oxy fuel burner	
Sulphur dioxide [c]	50 mg/Nm^3	200 mg/Nm^3	If scrubbing system is used	BAT will normally be to control sulphur releases by employing low sulphur fuels. Using higher sulphur fuels then scrubbing to achieve release limits will give rise to potentially significant cross-media effects
	500 mg/Nm^3, much lower if natural gas used as fuel	500 mg/Nm^3, much lower if natural gas used as fuel	If control exercised via sulphur content of fuel	
Hydrogen chloride [d]	10 mg/Nm^3	20 mg/Nm^3	Avoid scrap contaminated with chlorinated cutting oils and other chlorine sources	Presence in exhaust is an indicator of possible presence of dioxins
Carbon monoxide [e]	150 mg/Nm^3	300 mg/Nm^3	Effective burner control	
VOCs [f] (as Carbon)	50 mg/Nm^3	100 mg/Nm^3	Pre-treatment of potentially contaminated material. Effective burner control. Control over charging activity	
Dioxins [g]	0.1 ng/Nm^3 ITEQ		Purchase and inspection of scrap to avoid contaminated material. Pre-treatment. Carbon injection to filter	The BAT Reference document refers to higher levels under some circumstances. Where there is uncertainty about the individual isomers that are reported as "less than", a dual approach will be adopted where these values will be assumed to be zero and the result compared to these values as the limit of detection

It will not be necessary to specify limits for all of the above in all installations. For example, limits on products of combustion should not be applied to unheated milling plant handling drosses or slags.

[a] BREF tables 3.40; 3.41; 4.33; 4.34; 4.35; 5.47; 5.48; 6.16; 8.3; 8.4; 8.5; 8.6; 8.7; 8.8; 8.9; 9.11; 10.9; 11.16; 12.11; 12.12; 12.13; 12.14; 12.15 and 12.16.

[b] BREF tables 3.40; 4.34; 4.35; 5.47; 5.48; 6.16 and 11.16.

[c] BREF tables 3.40; 3.41; 5.48; 6.15 and 12.12.

[d] BREF tables 4.34; 4.35; 6.16 and 11.17.

[e] IPC Technical Guidance S2 2.03.

[f] BREF tables 3.40; 4.35; 5.47; 5.48; 6.15; 6.16; 11.16 and 11.17.

[g] BREF tables 3.40; 3.41; 4.35; 5.47; 5.48; 6.16 and 11.16.

Emission	Activity	Threshold annual use of solvent	Benchmark value as toluene mg/Nm^3	Basis for the benchmark
Solvents (various), see Solvent Directive 1999/13/EC	Coating and degreasing	2–10 tonnes > 10 tonnes	20 mg/Nm^3 20 mg/Nm^3	15% fugitive emission, 10% fugitive emission, fugitive emission expressed as % of use
High risk ,Extremely hazardous to health, such as benzene, vinyl chloride and 1,2–dichloroethane	Various		2 –5 mg/Nm3	Parity with previous UK Guidance Notes

Compliance with the Solvent Directive 1999/13/EC is required including the use of a solvent management plan. A reduction scheme may be used instead of emission limits.

3.2.1.2 Additional or varied requirements for specific classes of activity

(a) Copper and copper alloys – additional values for other components based on extractive samples.

BREF Section 3.4 refers

(i) Melting copper, making and melting copper alloys including pre-treatment

Emission	Benchmark level	Techniques which may be considered to be BAT	Comment
Phosphorus (as P_2O_5) [a]	5 mg/Nm^3		When phosphor copper is used for deoxidising copper
	50 mg/Nm^3	Limitation on maximum concentration of phosphorus in product. Wet scrubbing followed by high-energy filters, or high-energy venturi scrubbers	Manufacture of phosphor copper
Copper, lead, zinc, or their compounds [b]	2 mg/Nm^3 in total	Filtration	The suite of metals for which limits are defined may be extended beyond the list specified to include all those likely to be present, whether present intentionally or as a consequence of error. Also metals which are not present in the raw materials may be excluded
Cadmium, arsenic, nickel or their compounds [b]	0.5 mg/Nm^3 in total	Raw materials purchasing specification. Examination and testing upon receipt	
Beryllium [c]	0.005 mg/Nm^3	Avoid, if deliberately introduced, then absolute filtration is required	Used to improving precipitation and hardening in the manufacture of intricate castings

[a] IPC Technical Guidance S2 2.03.

[b] BREF tables 3.41 and 3.42.

[c] By extrapolation from occupational exposure limits.

(ii) Copper rod, wire and tube production: gas-fired shaft furnaces melting high purity copper

Emission	Benchmark level	Techniques which may be considered to be BAT	Comment
Particulate [ab]	5 mg/Nm^3	Fabric filter.	
VOCs [ab]	50 mg/Nm^3 (15 mg/Nm^3)	Quality control over raw materials and optimised combustion	
CO [abc]	1% at the burners (100 mg/Nm^3 if after-burners fitted)	Independent control of fuel/air ratio for each burner, with sequential gas monitoring	
NOx [ab] (as NO_2)	100 mg/Nm^3 (300 mg/Nm^3)	Low NOx burner Oxy-fuel burner	After-burners will increase emissions of NOx substantially

[a] BREF Section 3.1.4.

[b] BREF table 3.40.

[c] IPC Technical Guidance S2 2.03.

(b) Aluminium and aluminium alloys additional values for other components based on extractive samples

i) - Primary aluminium production: electrolysis cells [a]

Emission	Benchmark level	Techniques which may be considered to be BAT	Comment
Particulate	5 mg/Nm^3	Fabric filter	
Sulphur dioxide	30 kg/tonne of metal produced	Control via sulphur content of anodes	
Polyfluorinated hydrocarbons	0.1 kg /tonne	Optimise anode effect frequency	
Hydrogen fluoride	0.2mg/Nm^3 [b]	Use fabric filter pre-coated with alumina	The alumina used to be fed to the cell
Total fluoride	0.5mg/Nm^3 [b]		

[a] BREF table 4.33.

[b] Total mass release of fluorides from electrolysis, refining and anode manufacture shall not exceed 1.0 Kg F per tonne of metal produced at existing plant and 0.6 kg F per tonne of metal produced at new plant.

ii) Furnaces for melting aluminium and its alloys: holding furnaces [a]

Emission	Benchmark level	Techniques which may be considered to be BAT	Comment
Hydrogen chloride	10 mg/Nm^3	Control of raw materials. Dry scrubbing using lime insulated filter	If present when chlorine is not used, then origin should be identified
Fluorides	1 mg/Nm^3	As above	May be added as a constituent of a refining flux or as a contaminant from a primary smelter

(c) Lead, zinc and cadmium – additional values for other components based on extractive samples

(i) - All activities [abc]

Emission	Benchmark level	Techniques which may be considered to be BAT	Comment
Copper, lead, zinc, nickel, or their compounds	2 mg/Nm^3 in total as metal	Filtration	The suite of metals for which limits are defined may be extended beyond the list specified to include all those likely to be present, whether present intentionally or as a consequence of error. Also metals which are not present in the raw materials may be excluded
Antimony, tin, tellurium	2 mg/Nm^3 in total as metal	Filtration	
Cadmium, arsenic, mercury, thallium, selenium	0.5 mg/Nm^3 in total as metal	Raw materials purchasing specification. Examination and testing upon receipt	

[a] BREF tables 5.47 and 5.49.
[b] IPC Guidance IPR 2/4.
[c] IPC Guidance IPR 2/5.

(ii) Smelting operations where sulphur compounds are evolved [a]

Emission	Benchmark level	Techniques which may be considered to be BAT	Comment
Sulphur dioxide	99.7% removal	Conversion to sulphuric acid in double contact acid plant	Where the gas stream contains more than 5% sulphur dioxide
	200 mg/Nm^3	Single contact plant with gas scrubbing	Where the gas contains less than 5% sulphur dioxide or small installations where acid recovery is not practicable
Acid mist	50 mg/Nm^3		

[a] BREF table 5.46.

(d) Precious metals [ab] – additional values for other components based on extractive samples

Activity	Emission	Benchmark level	Techniques which may be considered to be BAT
Silver recovery: pre-treatment including incineration of photographic film	Lead, silver and their compounds	No individual element to exceed 2 mg/Nm^3	Filtration
Smelting silver residues	As above	As above	As above
Silver remelt operations	Cadmium	0.5 mg/Nm^3	As above
Miller process	Chlorine	3 mg/Nm^3	Process control and alkaline scrubber
	Metal chlorides	5 mg/Nm^3	As above
	Zinc oxide	5 mg/Nm^3	Reheating followed by fabric filter
All dry PGM activities and processes	Platinum group metals	Total metal content not to exceed 0.05 mg/Nm^3	High-efficiency filtration
Dissolution of PGMs	Chlorine and nitrosyl chloride	Total not to exceed 2 mg/Nm^3	Counter-current alkaline scrubber
	Hydrogen chloride	10 mg/Nm^3	
	Oxides of nitrogen	200 mg/Nm^3	
Precipitation	Ammonia	15 mg/Nm^3	Water scrubbing
Ignition	Ammonium chloride	10 mg/Nm^3	Process control to prevent loss of fine dusts, scrubbing to remove hydrochloric acid
	Hydrogen chloride	10 mg/Nm^3	
	Oxides of nitrogen	300 mg/Nm^3	
	Platinum group metals	Total metal content not to exceed 0.05 mg/Nm^3	
Fire refining	As lead process	Table (i) of Section 3.2.1.2.(c)	

[a] BREF Section 6.4, table 6.4.

[b] IPC Technical Guidance Note S2 4.04.

(e) Refractory metals and ferro alloys – additional values for other components based on extractive samples

Activity	Emission	Benchmark level	Techniques which may be considered to be BAT	Comment
Preparation and decomposition of ammonium paratungstate [a]	Ammonia	50 mg/Nm^3	Wet scrubbing	
Recovery of tungsten by the zinc process	Zinc and zinc oxide	5 mg/Nm^3	Filtration	
Molybdenum [a]	Sulphur dioxide, acid mist Ammonia	 50 mg/Nm^3		For sulphur releases, see table (ii) of Section 3.2.1.2 (c)
All processes [b]	Chromium, manganese, tungsten, vanadium, molybdenum, titanium, tantalum, niobium and rhenium and their compounds as appropriate	2 mg/Nm^3		

[a] BREF table 8.4.

[b] BREF tables 8.3; 8.4; 8.7; 8.9 and 9.11.

(f) Alkali and alkaline earth metals – additional values for other components based on extractive samples

Final discharge to air after chlorine recovery and scrubbing

Emission	Benchmark level	Techniques which may be considered to be BAT	Comment
Chlorine [a]	1 mg/Nm^3	Liquefaction, followed by treatment of inerts in a multi-stage scrubber	Cell room air shall also be treated to this standard by scrubbing

[a] BREF table 10.9.

(g) Nickel carbonyl process [a] – additional values for other components based on extractive samples

Emission	Benchmark level	Techniques which may be considered to be BAT	Comment
Nickel carbonyl	0.01 mg/Nm^3	Incineration	The release limit should be set at the practicable limit of detection

[a] BREF Section 11.1.3.5, table 11.17.

(h) Carbon manufacture – additional values for other components based on extractive samples

BREF Section 12.4.3.1 refers

Activity	Emission	Benchmark level	Techniques which may be considered to be BAT	Comment
Pitch storage [a]	Volatile hydrocarbons	10 mg/Nm^3	Condenser, adsorber	Gases should be back vented during delivery
	Condensable hydrocarbons	50 mg/Nm^3		
Mixing and grinding [b]	Polycyclic aromatic hydrocarbons[e] VDI i	10 µg/Nm^3	Adsorber/dry scrubber	A regenerative after-burner has been used on some applications
	Polycyclic aromatic hydrocarbons[e] VDI ii	100 µg/Nm^3		
	Total hydrocarbons	25 mg/Nm^3		
Bake furnace exhaust gases [cd]	Benzo-[*a*]-pyrene	0.05 mg/Nm^3 **	Alumina scrubber filter unit. ** Lower values are reported in the BREF but have been challenged. Further reductions should be sought for new plant.	The alumina used in this filter to be recycled into the reduction cell feed
	Polycyclic aromatic hydrocarbons[e] OSPAR 11	3 mg/Nm^3 **		
	Total hydrocarbons	10 mg/Nm^3		
	Gaseous fluoride	0.2mg/Nm^3		
	Total fluoride	0.5mg/Nm^3		

[a] BREF table 12.11.
[b] BREF table 12.12.
[c] BREF table 12.13.
[d] BREF table 12.14.
[e] For reporting convention for polycyclic aromatic hydrocarbons see table 12.10 in BREF 12.4.3.1.

3.2.2 VOCs

The term "volatile organic compounds" includes all organic compounds released to air in the gas phase.

Other applicable standards and obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements)

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

"Reducing Emissions of VOCs and Levels of Ground Level Ozone: A UK Strategy" was published by the Department of the Environment in October 1993. It sets out how the Government expects to meet its obligations under the UNECE VOCs Protocol to reduce its emissions by 30% (based on 1988 levels) by 1999, including the reductions projected for the major industrial sectors. Waste Treatment included in the "other miscellaneous industries" sector with no specific reduction targets stated.

The UNECE convention on long-range transboundary air pollution - Negotiations are now under way which could lead to a requirement further to reduce emissions of VOCs.

Benchmark emission values

Emission	Activity	Threshold annual use of solvent	Benchmark value as toluene mg/m^3	Basis for the Benchmark
Solvents (various) see Solvent Directive 1999/13/EC	coating and degreasing	2 – 10 tonnes > 10 tonnes	20 mg/m^3 20 mg/m^3	15% fugitive emission 10% fugitive emission Fugitive emission expressed as % of use.
High Risk Extremely hazardous to health, such as benzene, vinyl chloride and 1,2 - dichloroethane	various		2 –5 mg/m^3	Parity with previous UK Guidance Notes

Compliance with the Solvent Directive 1999/13/EC is required including the use of a solvent management plan. A reduction scheme may be used instead of emission limits.

3.2.3 Emissions to water associated with the use of BAT

3.2.3.1 Controlled waters

BREF Reference 2.9.2.2

Waste-water treatment systems can maximise the removal of metals using precipitation, sedimentation and filtration. The reagents used for precipitation will be defined by the mix of metals present, and may include hydroxide, sulphide or a combination of both. Concentrated effluents should be pre-treated before discharge into the final effluent treatment system, and techniques such as electrolysis, reverse osmosis and metal removal using ion exchange systems may need to be employed. Water discharges should be kept to a minimum by using closed cycle cooling systems and by maximising the re-use of treated process water.

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

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

Where spot samples are taken:

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

Benchmark emissions to water associated with the use of BAT are given in the following table. These are not emission limit values, and site-specific issues such as the raw material, the process and other technical characteristics will be taken into account when setting emission limit values:

BREF Reference 2.9.2.2
Tables 2.17, 2.19, 2.20, 2.21, 2.22 and 2.23

Substance	mg/litre
Total hydrocarbon oil	2
Biological oxygen demand (BOD) (5 day ATU at 20°C)	2.5
Chemical oxygen demand (COD) (2 hour)	125
Suspended solids	35
Cadmium and cadmium compounds expressed as Cd	0.01
Mercury and mercury compounds expressed as Hg	0.005
Copper and copper compounds expressed as Cu	0.5
Lead and lead compounds expressed as Pb	0.2
Arsenic and arsenic compounds expressed as As	0.1
Nickel and nickel compounds expressed as Ni	0.5
Zinc and zinc compounds expressed as Zn	0.5
Inorganic fluoride expressed as F	20
Silver expressed as Ag	0.5

The benchmarks are generally applicable for emissions to freshwater rivers. For discharges to estuaries higher values than those given above need to be justified on a site-specific basis at the time of the application. For very sensitive situations lower levels are achievable.

3.2.3.2 Discharges to a sewage treatment system

Discharges to a sewage treatment works will have different values depending on the site-specific conditions. However, the final discharge to controlled waters for the contribution from the IPPC installation, on a mass basis, should be equal to the above values after taking account of the volume of the waste water and effect of the sewage treatment process on the components.

3.2.4 Standards and obligations

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

(a) EC based EQ standards

IPPC: A Practical Guide (see Ref. 5) explains how these should be taken into account and contains an annex listing the relevant standards. (See Appendix 2 for equivalent legislation in Scotland and Northern Ireland.). They can be summarised as follows.

Air quality

- Statutory Instrument 1989 No 317, Clean Air, The Air Quality Standards Regulations 1989.
- Statutory Instrument 1997 No 3043, Environmental Protection, The Air Quality Regulations 1997.

Water quality

Directive 76/464/EEC on Pollution Caused by Dangerous Substances Discharged to Water contains two lists of substances. List I relates to the most dangerous, and standards are set out in various daughter Directives. List II substances must also be controlled. Annual mean concentration limits for receiving waters for List I substances can be found in SI 1989/2286 and SI 1992/337, the Surface Water (Dangerous Substances Classification) Regulations. Values for List II substances are contained in SI 1997/2560 and SI 1998/389. Daughter Directives cover EQS values for mercury, cadmium, hexachlorocyclohexane, DDT, carbon tetrachloride, pentachlorophenol, aldrin, dieldrin, endrin, isodrin, hexachlorobenzene, hexachlorobutadiene, chloroform, 1,2-dichloroethane, trichloroethane, perchloroethane and trichlorobenzene.

- Other waters with specific uses have water quality concentration limits for certain substances. These are covered by the following Regulations:
  - SI 1991/1597 Bathing Waters (Classification) Regulations;
  - SI 1992/1331 and Direction 1997 Surface Waters (Fishlife) (Classification) Regulations;
  - SI 1997/1332 Surface Waters (Shellfish) (Classification) Regulations;
  - SI 1996/3001 The Surface Waters (Abstraction and Drinking Water) (Classification) Regulations.

Future likely changes include:

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

(b) Other standards and obligations

Those which may have relevance to non-ferrous metals processes include:

- Waste Incineration Directive;
- Large Combustion Plant Directive;
- Reducing Emissions of VOCs and Levels of Ground Level Ozone: a UK Strategy;
- Water Quality Objectives – assigned water quality objectives to inland rivers and watercourses (ref. Surface (Rivers Ecosystem) Classification);
- The UNECE Convention on Long-Range Transboundary Air Pollution;
- The Montreal Protocol;
- The Habitats Directive (see Section 4.3).

3.2.5 Units for benchmarks and setting limits in Permits

Releases can be expressed in terms of:

- **"concentration"** (e.g. mg/l or mg/Nm^3) which is a useful day-to-day measure of the effectiveness of any abatement plant and is usually measurable and enforceable. The total flow must be measured/controlled as well;
- **"specific mass release"** (e.g. kg/$t_{product}$ or input or other appropriate parameter) which is a measure of the overall environmental performance of the plant (including the abatement plant) compared with similar plants elsewhere;
- **"absolute mass release"** (e.g. kg/h, t/yr) which relates directly to environmental impact.

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

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

4 IMPACT

4.1 Assessment of the impact of emissions on the environment

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

Application Form Question 4.1

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

With the application the Operator should:

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

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

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

4. Carry out an assessment of the potential impact of the total emissions from the activities on these receptors. Ref. 7 provides a systematic method for doing this and will also identify where modelling needs to be carried out, to air or water, to improve the understanding of the dispersion of the emissions. The assessment will include comparison (see *IPPC: A Practical Guide* (Ref. 5) and Section 3.2) with:
   - community EQS levels;
   - other statutory obligations;
   - non-statutory obligations;
   - environmental action levels (EALs) and the other environmental and regulatory parameters defined in Ref. 7.

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

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

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

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

4.2 The Waste Management Licensing Regulations

Application Form
Question 4.2

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

In relation to activities involving the disposal or recovery of waste, the Regulators are required to exercise their functions for the purpose of achieving the relevant objectives as set out in Schedule 4 of the Waste Management Licensing Regulations 1994. (For the equivalent regulations in Scotland, see Appendix 2. In Northern Ireland there are no equivalent regulations at the time of writing. Contact EHS for further information.)

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

a) "ensuring the waste is recovered or disposed of without endangering human health and without using process or methods which could harm the environment and in particular without:
   - risk to water, air, soil, plants or animals; or
   - causing nuisance through noise or odours; or
   - adversely affecting the countryside or places of special interest;

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

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

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

4.3 The Habitats Regulations

Application Form
Question 4.3

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

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

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

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

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

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

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

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

REFERENCES

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

1. The Pollution Prevention and Control Act (1999) (http://www.click-tso.com).
2. The Pollution Prevention and Control Regulations (SI 1973, 2000) (http://www.click-tso.com).
3. The EC Reference Document on BAT in the Non-Ferrous Metals Industry (the BREF Note)
4. BREF Note on Associated Foundry and Casting Operations
5. IPPC: A Practical Guide (for England and Wales) (or equivalents in Scotland and Northern Ireland) (http://www.environment-defra.gov.uk).
6. IPPC Part A (1) Installations: Guide for Applicants (includes **preparation of a site report**) – (http://www.environment-agency.gov.uk/business/techguide/ippc/107285/)
7. Assessment methodologies
   - E1 BPEO Assessment Methodology for IPC
   - IPPC Environmental Assessments for BAT (in preparation as H1)
8. Management system references:
   - Sector specific
9. Waste minimisation support references:
   - Environment Agency web site. Waste minimisation information accessible via: http://www.environment-agency.gov.uk/waste
   - Waste Minimisation – an environmental good practice guide for industry (helps industry to minimise waste and achieve national environmental goals). Available free to companies who intend to undertake a waste reduction programme (tel 0345 33 77 00)
   - Profiting from Pollution Prevention – 3Es methodology (emissions, efficiency, economics). Video and A4 guide aimed at process industries. Available from Environment Agency, North East region (tel 0113 244 0191, ask for regional PIR)
   - Waste Minimisation Interactive Tools (WIMIT). Produced in association with the ENVIROWISE and the BOC Foundation (a software tool designed for small and medium businesses). Available free from The Environmental Helpline (tel 0800 585794)
   - ENVIROWISE is a joint DTI/DEFRA programme, with over 200 separate case studies, good practice guides, leaflets, flyers, software tools and videos covering 12 industry sectors, packaging, solvents and the generic areas of waste minimisation and cleaner technology ENVIROWISE is accessible via a free and confidential helpline (tel 0800 585794) or via the web site, www.envirowise.org.uk/
   - ENVIROWISE, Increased Profit Through Improved Materials Additions: Management/Technical Guide, GG194/195
   - Waste Management Information Bureau. The UK's national referral centre for help on the full range of waste management issues. It produces a database called Waste Info, which is available for online searching and on CD-ROM. Short enquiries are free (tel 01235 463162)
   - Institution of Chemical Engineers Training Package E07 – Waste Minimisation. Basic course which contains guide, video, slides, OHPs, etc. (tel 01788 578214)
10. Water efficiency references:
    - ENVIROWISE, Simple measures restrict water costs, GC22
    - ENVIROWISE, Effluent costs eliminated by water treatment, GC24
    - ENVIROWISE, Saving money through waste minimisation: Reducing water use, GG26
    - ENVIROWISE Helpline 0800 585794
11. Environment Agency (1998) Optimum use of water for industry and agriculture dependent on direct abstraction: Best practice manual. R&D Technical Report W157, WRc Dissemination Centre, Swindon (tel 01793 865012)
12. Releases to air references:
    - BREF on Waste Water and Waste Gas Treatment
    - A1 Guidance on effective flaring in the gas, petroleum etc industries, 1993, ISBN 0-11-752916-8
    - A2 Pollution abatement technology for the reduction of solvent vapour emissions, 1994, £5.00, ISBN 0-11-752925-7
    - A3 Pollution abatement technology for particulate and trace gas removal, 1994, £5.00, ISBN 0-11-752983-4
    - Landfill gas flaring
    - Part B PG1/3 Boilers and Furnaces 20–50 MW net thermal input (ISBN 0-11-753146-4-7)
    - Part B PG1/4 Gas Turbines 20–50 MW net thermal input (ISBN 0-11-753147-2)
13. Releases to water references
    - BREF on Waste Water and Waste Gas Treatment

- A4 Effluent Treatment Techniques, TGN A4, Environment Agency, ISBN 0-11-310127-9 (EA web site)
- Environment Agency, Pollution Prevention Guidance Note – Above-ground oil storage tanks, PPG 2, gives information on tanks and bunding which have general relevance beyond just oil (EA web site)
- The Control of Pollution (Oil Storage) Regulations 2001.
- Mason, P. A., Amies, H. J., Sangarapillai, G. Rose, Construction of bunds for oil storage tanks, Construction Industry Research and Information Association (CIRIA), Report 163, 1997, CIRIA, 6 Storey's Gate, Westminster, London SW1P 3AU. Abbreviated versions are also available for masonry and concrete bunds (www.ciria.org.uk online purchase)

14. Dispersion Methodology Guide D1 (EA web site – summary only)
15. IPPC Energy Efficiency Guidance Note (the consultation version, available on the web site, should be used until the final version is published). Other energy efficiency guidance is given in the following EEBPP sources.
    - EEBPP publication – Non Ferrous Metals, the Essentials
    - EEBPP publication – A manager's guide to optimising furnace performance, GPG253
    - The Environment and Energy Helpline – 0800 585794
    - Websites http://www.energy-efficiency.gov.uk and http://www.thecarbontrust.co.uk
16. BS 5908: Code of Practice for Fire Precautions in the Chemical and Allied Industries
17. Environment Agency, Pollution Prevention Guidance Notes – Pollution prevention measures for the control of spillages and fire-fighting run-off, PPG 18, gives information on sizing fire water containment systems (EA web site)
18. Investigation of the criteria for, and guidance on, the landspreading of industrial wastes – final report to the DEFRA, the Environment Agency and MAFF, May 1998
19. Agency guidance on the exemption 7 activity (proposed)
20. COMAH guides:
    - A Guide to the Control of Major Accident Hazards Regulations 1999, Health and Safety Executive (HSE) Books L111, 1999, ISBN 0 07176 1604 5
    - Preparing Safety Reports: Control of Major Accident Hazards Regulations 1999, HSE Books HS(G)190, 1999
    - Emergency Planning for Major Accidents: Control of Major Accident Hazards Regulations 1999, HSE Books HS(G)191, 1999
    - Guidance on the Environmental Risk Assessment Aspects of COMAH Safety Reports, Environment Agency, 1999 (EA web site)
    - Guidance on the Interpretation of Major Accidents to the Environment for the Purposes of the COMAH Regulations, DEFRA, 1999, ISBN 753501 X, available from TSO
21. Assessment and Control of Environmental Noise and Vibration from Industrial Activities (joint agencies guidance in preparation)
22. Monitoring guidance (http://www.environment-agency.gov.uk/business/techguide/monitoring/):
    - M1 Sampling facility requirements for the monitoring of particulates in gaseous releases to atmosphere, March 1993, £5.00, ISBN 0-11-752777-7 (revision due 2002)
    - M2 Monitoring emissions of pollutants at source, January 1994, £10.00, ISBN 0-11-752922-2 (revision due 2002)
    - M3 Standards for IPC Monitoring Part 1: Standards, organisations and the measurement infrastructure, August 1995, £11.00, ISBN 0-11-753133-2 (revision due 2002)
    - M4 Standards for IPC Monitoring Part 2: Standards in support of IPC Monitoring, revised 1998 (revision due 2002)
    - M8 Environmental Monitoring Strategy – Ambient Air, 2001, £50. ISBN 0 11 310175 9
    - M9 Monitoring Methods for Ambient Air , 2001, £50. ISBN 0 11 310176 7
    - MCERTS approved equipment link via http://www.environment-agency.gov.uk/business/mcerts/ "Guidance for Business and Industry"
    - Direct Toxicity Assessment for Effluent Control: Technical Guidance (2000), UKWIR 00/TX/02/07
23. IPC Guidance Notes: (http://www.environment-agency.gov.uk/business/techguide/IPC/)
    - S2 1.01 Combustion Processes: large boilers and furnaces 50 MW(th) and over
    - S2 1.04 Combustion Processes: Waste and recovered oil burners 3 MW(th) and over
    - S2 4.03 Inorganic Acids and Halogens
24. The Categorisation of Volatile Organic Compounds, DOE Research Report No DOE/HMIP/RR/95/009 (http://www.environment-agency.gov.uk/business/techguide/publications/voc/)
25. Odour Assessment and Control – Guidance for Regulators and Industry (joint agencies guidance in preparation)
26. Policy and Practice for the Protection of Groundwater (PPPG) (EA web site)
27. Working at Construction and Demolition-sites (PPG 6) (EA web site)

DEFINITIONS AND ABBREVIATIONS

AFNOR	Association Française de Normalisation
APP	Alkaline peroxide process
AOX	Absorbable organic halogens
ASTM	American Society for Testing and Materials
BAT	Best available techniques – see *IPPC A Practical Guide* or the Regulations for further definition
BAT criteria	The criteria to be taken into account when assessing BAT, given in Schedule 2 of the PPC Regulations
BOD	Biochemical oxygen demand
BREF	BAT Reference Document
BSI	British Standards Institute
CCLA	Climate change levy agreement
CCTV	Closed circuit Television
CEM	Continuous emissions monitoring
CEN	Comité Européen de Normalisation
CHP	Combined heat and power
COD	Chemical oxygen demand
COS	Carbon oxy sulphide
DEFRA	Department of Environment, Food and Rural Affairs
DIN	Deutsches Institut für Normung
EAL	Environmental action level
EMAS	EC Eco Management and Audit Scheme
EMS	Environmental management system
EP	Electrostatic precipitator
EQS	Environmental quality standard
ETP	Effluent treatment plant
Gangue	Valueless material associated with an ore
GBR	General binding rules
Kw	Kilowatt
Kwh	Kilowatt hour
IPPC	Integrated Pollution Prevention and Control
ISO	International Standardisation Organisation
ITEQ	International Toxicity Equivalents
MCERTS	Monitoring Certification Scheme
NIEHS	Northern Ireland Environment and Heritage Service
NO_x	Oxides of Nitrogen
OPRA	Operator and Pollution Risk Appraisal
PAH	Polyaromatic hydrocarbons
PFC	Polyfluorinated hydrocarbons
PGM	Platignum group metals
PM_{10}	Particulate matter <10microns
PMs	Precious Metals
Ppv	Peak particle velocity
QA	Quality assurance
QC	Quality control
SAC	Special Area of Conservation
SCA	Society of Chemical Analysts
SECp	Specific energy consumption
SEPA	Scottish Environment Protection Agency
SPA	Special Protection Area
SSSI	Sites of Special Scientific Interest
TSS	Total suspended solids
TOC	Total organic carbon
US EPA	United States Environmental Protection Agency
VDI	Verein Deutscher Ingenieure
VDV	Vibration dose value
VOC	Volatile organic compound

APPENDIX 1 Some Common Monitoring and Sampling Methods

Table A1.1 Measurement methods for common substances to water

Determinand	Method	Detection limit and uncertainty	Valid for range (mg/l)	Standard
Suspended solids	Filtration through glass fibre filters	1 mg/l 20%	10–40	ISO 11929: 1997 EN872 Determination of suspended solids
COD	Oxidation with dichromate	12 mg/l 20%	50–400	ISO 6060: 1989 Water Quality- Determination of chemical oxygen demand
BOD_5	Seeding with micro organisms and measurement of oxygen content	2 mg/l 20%	5–30	ISO 5815: 1989 Water Quality – Determination of biological oxygen demand after 5 days, dilution and seeding method EN1899 (BOD 2 Parts)
AOX	Adsorption on activated carbon and combustion	– 20%	0.4–1.0	ISO 9562: 1998 EN1485 – Determination of adsorbable organically bound halogens.
Total P				BS 6068: Section 2.28 1997 Determination of phosphorus –ammonium molybdate spectrometric method
Total N				BS 6068: Section 2.62 1998 – Determination of nitrogen Part 1 Method using oxidative digestion with peroxydisulphate BS EN ISO 11905
pH				SCA The measurement of electric conductivity and the determination of pH, ISBN 0117514284
Turbidity				SCA Colour and turbidity of waters 1981, ISBN 0117519553 EN27027:1999
Flowrate	Mechanical ultrasonic or electromagnetic gauges			SCA Estimation of flow and load, ISBN 011752364X
Temperature				
TOC				SCA The instrumental determination of total organic carbon and related determinants, 1995, ISNB 0117529796 EN1484:1997
Fatty acids				Determination of volatile fatty acids in sewage sludge, 1979, ISBN 0117514624
Metals				BS 6068: Section 2.60 1998 – Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy
Chlorine				BS6068: Section 2.27 1990 – Method for the determination of total chlorine: iodometric titration method
Chloroform, bromoform				BS 6068: Section 2.58 Determination of highly volatile halogenetaed hydrocarbons – Gas chromatographic methods
Dispersants, Surfactants: Anionic, Cationic, non-ionic				SCA Analysis of surfactants in waters, wastewaters and sludges, ISBN 01176058 EN903:1993 (Used for anionic surfactants)
Pentachloro-phenol				BS5666 Part 6 1983 – Wood preservative and treated timber quantitative analysis of wood preservatives containing pentachlorophenol EN12673:1997 (used for chlorophenol and polychlorinated phenols)
Formaldehyde				SCA The determination of formaldehyde, other volatile aldehydes and alcohols in water
Phosphates and nitrates				BS 6068: Section 2.53 1997 Determination of dissolved ions by liquid chromatography
Sulphites and sulphates				BS 6068: Section 2.53 1997 Determination of dissolved ions by liquid chromatography
Ammonia				BS 6068: Section 2.11 1987 – Method for the determination of ammonium: automated spectrometric method
Grease and oils	IR absorption	0.06 mg/kg		SCA The determination of hydrocarbon oils in waters by solvent extraction IR absorption and gravimetry, ISBN 011751 7283

Table A1.2: Measurement methods for air emissions

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

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

See also Monitoring Guidance (Ref. 22).

APPENDIX 2 Equivalent Legislation In Scotland and Northern Ireland

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

Table A2.1 Equivalent legislation

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