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Integrated Pollution Prevention and Control (IPPC) Guidance for the Production of Coke, Iron and Steel



Environment
Agency

Commissioning Organisation

Environment Agency
Rio House
Waterside Drive
Aztec West
Almondsbury
Bristol BS32 4UD
Tel 01454 624400 Fax 01454 624409

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Liz Greenland
Environment Agency
Data & Information Exploitation Unit
130 Aztec
Park Avenue
Almondsbury
Bristol
BS32 4UB

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Table 0.1: Record of changes

Version	Date	Change	Template Version
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Consultation	April 2001	Issued for consultation	N/A
Issue 1 (Draft)	October 2002	Incorporates changes arising from consultation	N/A
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Note:

Written comments or suggested improvements should be sent to pirhelp@environment-agency.gov.uk or to:

PIR Process Management
Environment Agency
Block 1, Government Buildings
Burghill Road
Westbury-on-Trym
Bristol.
BS10 6BF
Telephone 0117-914-2871

Executive summary

Status of this Guidance	This guidance has been produced by the Environment Agency , with the Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment and Heritage Service (EHS) - each referred to as “the Regulator” throughout this document. Its publication follows consultation with industry, government departments and non-governmental organisations.
What is IPPC	Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control all environmental impacts of certain listed industrial activities. In the UK, the IPPC Directive is implemented through the English and Welsh, the Scottish, and the Northern Irish versions of the Pollution Prevention and Control (PPC) Regulations. It involves determination by the Regulator of the appropriate controls for those industries to protect all environmental media, through a single permitting process. To gain a PPC Permit, an Operator has to demonstrate in its Application, in a systematic way, that the techniques it is using or is proposing to use, both represent the use of Best Available Techniques (BAT), taking account of relevant local factors, and meet other relevant statutory requirements.
This Guidance and the BREF	Much UK Technical Guidance on what is BAT is based on the “BAT Reference documents” (“BREFs”) produced by the European Commission. BREFs are the result of exchanges of information between member states and industry, with most covering individual industrial sectors, and some (“horizontal” BREFs) covering cross-sectoral subjects. UK Technical Guidance Notes are designed to complement BREFs, and take into account information contained in relevant BREFs in setting out indicative BAT standards and expectations for England and Wales, Scotland and Northern Ireland.
The aims of this Guidance	<p>The aim of this Guidance is to provide Operators and officers of the Regulator with advice on indicative standards of operation and environmental performance, relevant to the industrial sector concerned. It also aims (through linkage with the Permit Application Form template) to provide a clear structure and methodology for Operators to follow to ensure they address adequately all aspects of the PPC Regulations and relevant aspects of other environmental Regulations. Also, by expressing BAT techniques as clear indicative standards wherever possible, it aims to minimise the effort involved for both Operator and Regulator in the permitting of an installation.</p> <p>To further assist Operators in making Applications, separate horizontal guidance is available on a range of topics such as noise, odour, waste minimisation, monitoring, calculating stack heights and so on. Most of this guidance is available free through the Environment Agency, SEPA or EHS (Northern Ireland) websites (see References).</p>
key environmental issues	<p>The key environmental issues for this sector are summarised in Section 1.5 and concern:</p> <ul style="list-style-type: none">• fugitive and controlled emissions to air• management and emissions of water• recovery and recycling of by-products and disposal of waste• use of process fuel gases and energy efficiency (covered by Climate Change Levy Agreement)

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1 Introduction

The status and aims of this Guidance

This Guidance has been produced by the Environment Agency for England and Wales, with the Scottish Environment Protection Agency (SEPA) and the Environment and Heritage Service (EHS) in Northern Ireland - each referred to as “the Regulator” in this document. Its publication follows consultation with industry, Government departments and non-governmental organisations.

It aims to provide Operators and the Regulator’s officers with advice on indicative standards of operation and environmental performance relevant to the industrial sector concerned, to assist the former in the preparation of applications for PPC Permits and to assist the latter in the assessment of those Applications (and the setting of a subsequent compliance regime). The use of techniques quoted in the guidance and the setting of emission limit values at the benchmark values quoted in the guidance are not mandatory, except where there are statutory requirements from other legislation. However, the Regulator will carefully consider the relevance and relative importance of the information in the Guidance to the installation concerned when making technical judgments about the installation and when setting Conditions in the Permit, any departures from indicative standards being justified on a site-specific basis.

The Guidance also aims (through linkage with the Application Form or template) to provide a clear structure and methodology for Operators to follow to ensure they address all aspects of the PPC Regulations and other relevant Regulations, that are in force at the time of writing. Also, by expressing the Best Available Techniques (BAT) as clear indicative standards wherever possible, it aims to minimise the effort required by both Operator and Regulator to apply for and issue, respectively, a Permit for an installation.

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1.1 Understanding IPPC

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 listed industrial activities. It involves determination by the Regulator of the appropriate controls for those industries to protect the environment, through a single permitting process. To gain a Permit, Operators have to demonstrate in their Applications, in a systematic way, that the techniques they are using or are proposing to use, are the Best Available Techniques (BAT) for their installation, and meet certain other requirements, taking account of relevant local factors.

The essence of BAT is that the techniques selected to protect the environment should achieve an appropriate balance between environmental benefits and the costs incurred by Operators. However, whatever the costs involved, no installation may be permitted where its operation would cause significant pollution.

IPPC operates under [The Pollution Prevention and Control Regulations](#) (for equivalent legislation in Scotland and N Ireland see [Appendix 2](#)). The three regional versions of the PPC Regulations implement in the UK the EC Directive on IPPC (96/61/EC). Further information on the application of IPPC/PPC, together with Government policy and advice on the interpretation of the English & Welsh Regulations, can be found in [IPPC: A Practical Guide](#) published by the Department for Environment, Food and Rural Affairs (Defra). Equivalent guidance on the Scottish Regulations is provided in [PPC Regulations: A Practical Guide \(Part A Activities\)](#), published by the Scottish Executive and SEPA. The Department of the Environment, Northern Ireland has published equivalent guidance on its Regulations.

Installation based, NOT national emission limits

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

Indicative BAT Standards

Indicative BAT standards are laid out in national guidance (such as this) and, where relevant, should be applied unless a different standard can be justified for a particular installation. BAT includes the technical components, process control, and management of the installation given in Section 2, and the benchmark levels for emissions identified in Section 3. Departures from those benchmark levels can be justified at the installation level by taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. If any mandatory EU emission limits or conditions are applicable, they must be met, but BAT may go further (see "BAT and EQS" below).

Some industrial sectors for which national guidance is issued are narrow and tightly defined, whilst other sectors are wide and diffuse. This means that where the guidance covers a wide variety of processes, and individual techniques are not described in detail, the techniques (and their associated emission levels) which might constitute BAT for a particular operation, are more likely to differ, with justification, from the indicative BAT standards than would be the case for a narrow, tightly-defined sector.

BAT and EQS

The BAT approach complements, but differs fundamentally from, regulatory approaches based on Environmental Quality Standards (EQS). Essentially, BAT requires measures to be taken to prevent emissions - and measures that simply reduce emissions are acceptable only where prevention is not practicable. Thus, if it is economically and technically viable to reduce emissions further, or prevent them altogether, then this should be done irrespective of whether or not EQSs are already being met. The BAT approach 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 emissions from industrial activities and their impact. The BAT approach first considers what emission prevention can reasonably be achieved (covered by Sections 2 and 3 of this Guidance) and then checks to ensure that

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the local environmental conditions are secure (see [Section 4](#) of this Guidance and also Guidance Note [IPPC Environmental Assessments for BAT](#)). The BAT approach is therefore the more precautionary one because the release level achieved may be better than that simply required to meet an EQS.

Conversely, if the application of indicative BAT might lead to a situation in which an EQS is still threatened, a more effective technique is required to be BAT for that installation. The Regulations allow for expenditure beyond indicative BAT where necessary, and, ultimately, an installation will only be permitted to operate if it does not cause significant pollution.

Further advice on the relationship between BAT, EQSs and other related standards and obligations is given in [IPPC: A Practical Guide](#), its Scottish equivalent, and also in Section 3.

Assessing BAT at the sector level

The assessment of indicative BAT takes place at a number of levels. At the European level, the European Commission issues a “BAT reference document” (BREF) for each main IPPC sector. It also issues “horizontal” BREFs for a number of general techniques which are relevant across a series of industrial sectors. The BREFs are the result of an exchange of information between regulators, industry and other interested parties in Member States. Member States should take them into account when determining BAT, but they are allowed flexibility in their application. UK Sector Guidance Notes like this one take account of information contained in relevant BREFs and set out current indicative standards and expectations in the UK. At national level, techniques that are considered to be BAT should represent an appropriate balance of costs and benefits for a typical, well-performing installation in the sector concerned. They should also be affordable without making the sector as a whole uncompetitive, either within Europe or world-wide.

Assessing BAT at the installation level

When assessing applicability of sectoral indicative BAT standards at the installation level, departures may be justified in either direction. Selection of the technique which is most appropriate may depend on local factors and, where the answer is not self-evident, an installation-specific assessment of the costs and benefits of the available options will be needed. The Regulator’s guidance [IPPC Environmental Assessments for BAT](#) and its associated software tool may help with the assessment. Individual installation or company profitability (as opposed to profitability of the relevant sector as a whole) is not a factor to be considered, however.

In the assessment of BAT at the installation level, the cost of improvements and the timing or phasing of that expenditure, are always factors to be taken into account. However, they should only be major or decisive factors in decisions about adopting indicative BAT where:

- the installation’s technical characteristics or local environmental conditions can be shown to be so different from those assumed in the sectoral assessment of BAT described in this guidance, that the indicative BAT standards may not be appropriate; or
- the BAT cost/benefit balance of an improvement only becomes favourable when the relevant item of plant is due for renewal/renovation (eg. change to a different design of furnace when the existing furnace is due for a rebuild). In effect, these are cases where BAT for the sector can be expressed in terms of local investment cycles; or
- a number of expensive improvements are needed. In these cases, a phasing programme may be appropriate - as long as it is not so drawn out that it appears to be rewarding a poorly performing installation.

In summary, departures by an individual installation from indicative BAT for its sector 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 the basis of individual company profitability, or if significant pollution would result. Further information on this can be found in [IPPC: A Practical Guide](#) and [IPPC Part A\(1\) Installations: Guide for Applicants](#), or the equivalent Scottish Guidance.

Innovation

The Regulators encourage the development and introduction of innovative techniques that advance indicative BAT standards criteria, ie. techniques which have been developed on a scale which reasonably allows implementation in the relevant sector, which are technically and economically viable

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and which further reduce emissions and their impact on the environment as a whole. One of the main aims of the PPC legislation is continuous improvement in the overall environmental performance of installations as a part of progressive sustainable development. This Sector Guidance Note describes the indicative BAT standards at the time of writing but Operators should keep up-to-date with improvements in technology - and this Guidance note cannot be cited as a reason for not introducing better available techniques. The technical characteristics of a particular installation may also provide opportunities not foreseen in the Guidance, and as BAT is determined at the installation level (except in the case of General Binding Rules (GBRs)), it is a requirement to consider these even where they go beyond the indicative Standards.

New installations

Indicative BAT standards apply, where relevant, to both new and existing installations, but it will be more difficult to justify departures in the case of new installations (or new activities in existing installations) - and for new activities, techniques which meet or exceed indicative BAT requirements should normally be in place before operations start.

Existing installations - standards

For an existing installation, it may not be reasonable to expect compliance with indicative BAT standards immediately if the cost of doing so is disproportionate to the environmental benefit to be achieved. In such circumstances, operating techniques that are not at the relevant indicative BAT standard may be acceptable, provided that they represent what is considered BAT for that installation and otherwise comply with the requirements of the Regulations. The determination of BAT for the installation will involve assessment of the technical characteristics of the installation and local environmental considerations, but where there is a significant difference between relevant indicative BAT and BAT for an installation, the Permit may require further improvements on a reasonably short timescale.

Existing installations - upgrading timescales

Where there are departures from relevant indicative BAT standards, Operators of existing installations will be expected to have upgrading plans and timetables. Formal timescales for upgrading will be set as Improvement Conditions in the Permits. See [Section 1.4.2](#) for more details.

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1.2 Making an application

A satisfactory Application is made by:

- addressing the issues in Sections 2 and 3 of this guidance;
- assessing the environmental impact described in Section 4 (and in England and Wales [Environmental Assessment and Appraisal of BAT \(IPPC H1\)](#));
- demonstrating that the proposed techniques are BAT for the installation.

In practice, some Applicants have submitted far more information than was needed, yet without addressing the areas that are most important - and this has led to extensive requests for further information. In an attempt to focus application responses to the areas of concern to the Regulator, Application forms (templates) have been produced by the Environment Agency, by SEPA and by EHS in N Ireland. In addition, as the dates for application have approached, the operators in most industrial sectors in England and Wales have been provided with Compact Discs (CDs) which contain all relevant Application Forms, technical and administrative guidance, BREFs and Assessment tools, hyper-linked together for ease of use.

For Applicants with existing IPC Authorisations or Waste Management Licences, the previous applications may provide much of the information for the PPC application. However, where the submitted Application refers to information supplied with a previous application the Operator will need to send fresh copies - though for many issues where there is a tendency for frequent changes of detail (for example, information about the management systems), it will be more appropriate simply to refer to the information in the Application and keep available for inspection on site, up-to-date versions of the documents.

For further advice see [IPPC Part A\(1\) Installations: Guide for Applicants \(for England and Wales\)](#) or [PPC Part A Installations: Guide for Applicants \(for Scotland\)](#) or the equivalent Northern Ireland guide for Applicants.

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1.3 Installations covered

This Guidance relates to installations containing the activities listed below, as described in Part A(1) of Schedule 1 to the [The Pollution Prevention and Control Regulations](#). The schedules of listed activities are slightly different in Scotland and Northern Ireland so for their equivalent Regulations see [Appendix 2](#)

Section 1.2 - Gasification, Liquefaction and Refining Activities

Part A(1) (c) Operating coke ovens

and

Section 2.1 - Ferrous metals:

Part A(1)

- (a) *Roasting or sintering metal ore, including sulphide ore, or any mixture of iron ore with or without other materials.*
- (b) *Producing, melting or refining iron or steel or any ferrous alloy, including continuous casting, except where the only furnaces used are:*
 - (i) *electric arc furnaces with a designed holding capacity of less than 7 tonnes, or*
 - (ii) *cupola, crucible, reverberatory, rotary, induction or resistance furnaces.*
- (c) *Loading, unloading or otherwise handling or storing more than 500,000 tonnes in total in any period of 12 months of iron ore, except in the course of mining operations, or burnt pyrites.*

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

- raw materials handling
- sintering
- coke making
- blast furnace iron making
- hot metal mixing
- iron desulphurisation
- basic oxygen steel making
- electric arc steel making
- secondary steel making
- slag handling and processing
- continuous casting
- ingot casting
- scarfing
- skull burning

and the following activities that will be covered under separate guidance:

- ferro-alloys (see Non-ferrous Metals BREF and Sector Guidance Note IPPC S2.02)
- rolling (including reheat furnaces) (see Sector Guidance Note IPPC S2.04)
- pickling and cleaning (see Sector Guidance Note IPPC S2.04)
- power plant
- landfill

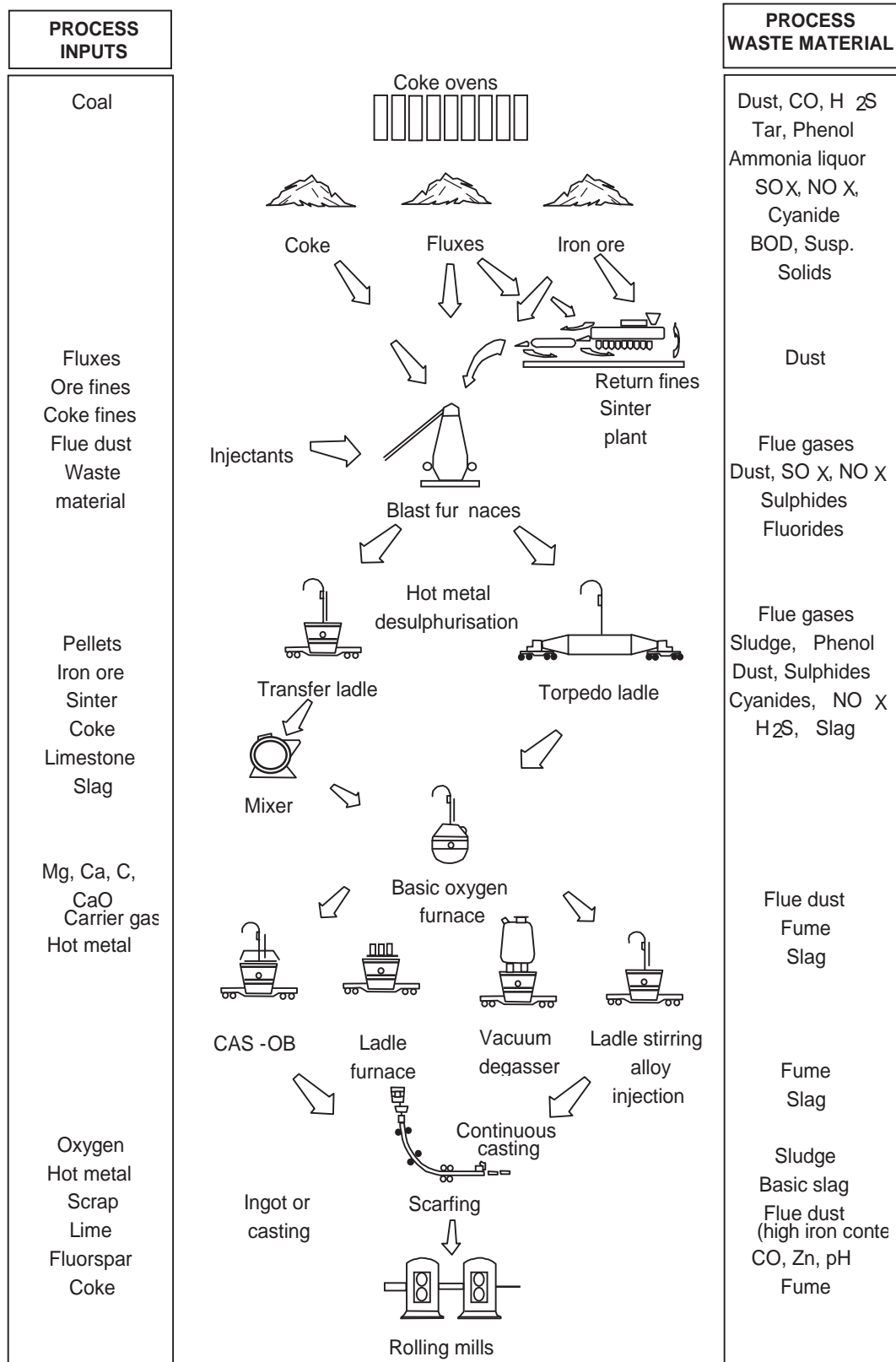
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Figure 1.1 is a schematic of the main activities for an integrated iron and steelworks and Figure 2-6 in Section 2 shows the main activities of an electric arc furnace plant.

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

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Figure 1.1: Integrated steelworks process route



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Advice on the extent of the physical site which is contained within the installation, e.g. split sites, is given in *IPPC Part A(1) Installations: Guide for Applicants* (see [IPPC Part A\(1\) Installations: Guide for \(Applicants England and Wales\) \(includes Preparation of a Site Report in a Permit Application\) \(EA website\)](#)). Operators are advised to discuss this issue with the Regulator prior to preparing their application.

An example for a typical integrated iron and steel works installation would be as follows:

The stationary technical unit (STU) would comprise the following Part A(1) activities: iron ore storage and handling (starting at the unloading operation at docks, if on same site), sintering, coke making (including by-products plant), blast furnaces, basic oxygen steel making, secondary steel making, continuous casting, hot rolling, prescribed surface treatments and prescribed combustion plant (including reheat furnaces).

Directly associated activities meeting Limb (ii) of the installation definition, which typically would include (**if on site**): unloading, transport, storage and treatment of raw materials to the STU (including iron ore, coal, steel scrap, fluxing agents and other additives); hot metal transfers, tipping and recovery (“plating” or “ponding”); ingot cutting; scarfing; packaging and warehousing of product (if risk of pollution, e.g. noise); on-line process analysis and control facilities for the STU; collection and use of BF and BOS gases; aqueous effluent treatment facilities; briquetting of recovered BOS fines; millscale handling; slag handling; slag granulation; metal recovery from slag; storage of intermediate and by-products and wastes.

Directly associated activities may include those listed under Part A (2) or Part B of Chapters in Schedule 1 of the Regulations. For example, applying protective fused metal coatings (Chapter 2, Section 2.1, Part A(2)) and iron desulphurisation (Section 2.1, Part B).

The following are not likely to be included: production of oxygen, nitrogen and other industrial gases; tar refining; benzole refining; slag processing to produce other products (e.g. grinding to produce cement and road stone coating); quality control laboratories and offices.

In England and Wales, landfills falling under Section 5.2 in Part 1 of Schedule 1 of the PPC Regulations 2000, which would otherwise form part of the installation, were decoupled under The Landfill (England and Wales) Regulations 2002. An application will be required at a date specified by the regulator later. If issued with a permit, the landfill may again be part of the installation.

The scope of an installation for the purposes of a Negotiated Agreement (NA) under the Climate Change Levy is a matter for the DETR. It may not coincide with the scope of an installation under PPC regulation as some scale thresholds in Schedule 1 do not apply for the purposes of a NA installation.

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

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

The installation will also include **associated activities** which have a technical connection with the main activities and which may have an effect on emissions and pollution, as well as the main activities described above. These may involve activities such as:

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

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Environment Agency advice on the composition of English or Welsh installations and which on-site activities are to be included within it (or them) is given in its guidance document [IPPC Regulatory Guidance Series No.5 - Interpretation of “Installation” in the PPC Regulations](#). Operators are advised to discuss the composition of their installations with the Regulator before preparing their Applications.

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1.4 Timescales

1.4.1 Permit review periods

Permits are likely to be reviewed as follows:

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

However, where discharges of Groundwater List I or List II substances have been permitted, or where there is disposal of any matter that might lead to an indirect discharge of any Groundwater List I or II substance, a review must be carried out within four years as a requirement of the Groundwater Regulations.

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

1.4.2 Upgrading timescales for existing plant

Existing installation timescales

Unless subject to specific conditions elsewhere in the Permit, upgrading timescales will be set in the Improvement Programme of the Permit, having regard to the criteria for improvements in the following two categories:

- 1 *Standard “good-practice” requirements, such as, management systems, waste, water and energy audits, bunding, housekeeping measures to prevent fugitive or accidental emissions, good waste-handling facilities, and adequate monitoring equipment.* Many of these require relatively modest capital expenditure and so, with studies aimed at improving environmental performance, they should be implemented as soon as possible and generally well within 3 years of issue of the Permit.
- 2 *Larger, more capital-intensive improvements, such as major changes to reaction systems or the installation of significant abatement equipment.* Ideally these improvements should also be completed within 3 years of Permit issue, particularly where there is considerable divergence from relevant indicative BAT standards, but where justified in objective terms, longer time-scales may be allowed by the Regulator.

Local environmental impacts may require action to be taken more quickly than the indicative timescales above, and requirements still outstanding from any upgrading programme in a previous permit should be completed to the original time-scale or sooner. On the other hand, where an activity already operates to a standard that is close to an indicative requirement a more extended time-scale may be acceptable. Unless there are statutory deadlines for compliance with national or international requirements, the requirement by the Regulator for capital expenditure on improvements and the rate at which those improvements have to be made, should be proportionate to the divergence of the installation from indicative standards and to the environmental benefits that will be gained.

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The Operator should include in the Application a proposed programme in which all identified improvements (and rectification of clear deficiencies) are undertaken at the earliest practicable opportunities. The Regulator will assess BAT for the installation and the improvements that need to be made, compare them with the Operator's proposals, and then set appropriate Improvement Conditions in the Permit

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1.5 Key issues

Note Radioactive substances are covered by the Radioactive Substances Act 1993 not IPPC

**BAT improvements:
Emphasis on control
Improve main & dedust EP
Reduced PCDD/F**

**BAT improvements:
Dust free charging
Low NO_x burners
Integral hood on coke
guide and remote
abatement
COG desulphurisation
'Gas tight' by-products
More self monitoring**

**BAT improvements:
Cast house fume
abatement
Emphasis on control
Water recycling**

**BAT improvements:
Emphasis on control
Slag re-use
More self monitoring**

Nature and consumption of raw and recycled materials

Selection and use of materials (including scrap) to give the best practicable environmental option.

Raw material handling

Fugitive dust emissions from unloading, transport, storage and reclamation of stocks principally of scrap metal, iron ore, fluxes, coal and coke. Detection of contamination of scrap with radioactive materials, excessive non-metallics, oil, PCB, etc. Contamination of surface water run-off.

Sintering

The most important issues concerning sintering processes are as follows:

- control of inputs and the process itself
- emissions of dust, PCDD/F, heavy metals, SO₂ and NO_x in waste gases
- management of revert materials

Coke making

The key issues concerning coke making are as follows:

- emission of dust and fume from coal charging and coke pushing and fugitive fume from battery and by-product plant
- coke oven gas treatment (including desulphurisation) and low NO_x burners
- release of coke oven gas by bleeder without ignition
- storage and handling of process chemicals in by-products plant
- waste water treatment (particularly concerning ammonia)

Blast furnace iron making

The most important issues concerning blast furnace iron making are as follows:

- blast furnace gas containment
- blast furnace gas treatment and utilisation
- bleeder openings
- cast house fume control
- use of reductants other than coke
- "plating" or "ponding" of surplus iron
- storage and use of oil
- H₂S emissions from slag cooling
- slag handling
- treatment of wastewater from blast furnace gas scrubbing

Basic oxygen steel making

The key issues concerning basic oxygen steel making are as follows:

- blow management
- primary and secondary fume control
- formation of graphite "kish"
- scarfing
- slag handling and metal recovery techniques

Introduction			Techniques			Emissions		Impact
Understanding IPPC	Making an application	Installations covered	Timescales	Key issues	Summary of releases	Technical overview	Economics	

BAT improvements:
Dust recycling
Post combustion
Reduced PCDD/F
More self monitoring

Electric arc steel making

The most important issues concerning electric arc steel making are as follows:

- post combustion
- primary and secondary dust control
- control of organic emissions such as PCDD/F
- recycling of arc furnace and other dusts
- control of fugitive emissions
- scrap preparation
- slag handling

BAT improvements:
Air quality management plan to meet AQS objectives

Air quality management

Iron and steel making works are significant emitters of SO₂, particulate, NO_x, CO, iron and its oxides, heavy metals and organochlorides including PCDD/F. Coke works emit dust and VOC, including benzene and PAH.

Water management

Key issues to be addressed include the following:

- consumption levels
- monitoring and management of mass flows of individual pollutants
- management of surface water run-off and treatment facilities
- security of underground drains
- pollution prevention systems and contingency arrangements

Operators in CCL Agreement are not expected to implement capital improvement projects for energy efficiency under a PPC Permit

Energy efficiency and fuels

The sector is a major energy producer and consumer. At integrated works, energy management systems already aim to make good use of process gases, i.e. COG, BF and BOS gases. Opportunities exist to further reduce energy consumption.

A Negotiated Agreement has been made between the UK Steel Association and the Government concerning a rebate of the Climate Change Levy (CCL). Signatories will be subject to a reduced level of site specific regulation on energy efficiency matters, in particular capital expenditure is not required on energy efficiency improvements beyond the baseline measures (though a plan has to be provided in case the Operator drops out of the agreement). Some activities covered here may be exempt from the CCL, e.g. coke making. The applicability of techniques and standards for PPC is explained in Section 2.7.

Key issues include:

- BOS gas recovery and treatment
- energy efficiency for EAF
- minimising use of heavy fuel oil
- low NO_x combustion systems
- the balance between energy use and environmental protection.

Recovery, recycling and waste disposal

A strategy and plan are required for the minimisation, recovery and recycling of process materials and disposal of waste, in accordance with the Regulator's policies on waste minimisation. Considerations should include collected dusts, process waters, treated effluents and recovered oils. Wastes sent to landfill are a key issue, particularly BOS slag and slurry, millscale sludge, demolition waste, spent pickle liquor, blast furnace slurry and refractories.

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Noise

There are major noise sources on these sites, in particular: bleeders on high pressure blast furnaces; steel and scrap handling; steam and hot metal explosions. All potential sources of significant noise need to be identified and managed.

Accident risk and pollution prevention

An assessment is required of the environmental hazards posed by non-routine operation and accidents. This can be co-ordinated with any responsibilities under the COMAH Regulations. Appropriate pollution prevention measures and contingency arrangements are required, protecting all environmental media.

Long distance and transboundary pollution

Integrated works produce emissions of SO₂, and a lesser extent PM10 and NO_x, which may be of long distance and transboundary significance.

Site restoration

Some areas for consideration for remediation would include:

- contamination of stocking and handling areas for raw and recycled materials
- aromatic contamination of coking works sites
- heavy metals and alkaline materials at slag and metal recovery operations in alloy steel production
- alkaline and sulphide contamination at other slag sites
- sediments in lagoons

1.6 Summary of releases

Table 1.1: Potential release routes for prescribed substances and other substances that may cause harm

Part 1 of 3 - Iron and Steel																
SOURCE RELEASES	Raw material handling	Sinter plant: flue gas cleaning	Sinter plant: secondary emissions	Coal pulverisation	Hot blast stoves	Stockhouse	Blast furnace primary gas cleaning	Casthouse	Desulphurisation	BOS: blowing (primary emissions)	BOS: charging/tapping (secondary emissions)	EAF: charging	EAF: melting and refining	EAF: steel and slag tapping	EAF: furnace and ladle lining repairs	Alloy addition and injection
Oxides of sulphur		A			A			A	A	A		A	A			A
Oxides of nitrogen		A			A							A	A			
Carbon dioxide		A			A		A		A	A	A	A	A			
Carbon monoxide		A			A		A		A	A		A	A			
Hydrogen chloride		A									A	A				
Hydrogen fluoride		A											A			
Hydrogen sulphide							A									
Ammonia							w									
Oxides of iron	Aw	A	A			A	A	A	A	A	A	A	A	A	AI	A
Alkali metals		A	A				A	A	AL	A	A					
Alkaline-earth metals		A	A			A	A	A	AL	A	A					
Metal oxide particulates	Aw	A	A			A	A	A	A	A	A					
Non-metallic particulates	Aw	A	A	A		A	A	A	A	A	A					
Metallic iron											A				AI	
Inorganic fluorides							A			A	A				AI	A
Hydrogen cyanide							w								ALI	A
Cadmium and cadmium oxide	W	A					A			A	A	A	A			
Zinc, lead and their oxides	w	A					A			A	A	A	A			
Other metals and their oxides	Aw											A	A	A		
Phosphorus compounds							wl			Awl						
Sulphur									I	A						
Carbon							A				A					
Other inorganic chemicals	AW											A	A		AI	
Oils and greases	w															
Slag waste							LI			LI			LI	LI	AI	ALI
Sludges							wLI		LI	wLI						
Refractory waste	Aw														ALI	
Dioxins		A									A	A				
Volatile organic compounds		A					A				A					
KEY	Main polluting substances (defined in Schedule 5 of SI 2000 No 1973):						A – Release to Air, W – Release to Water, L – Release to Land									
	Other substances which may cause harm:						a – Release to Air, w – Release to Water, l – Release to Land									
Substances include their compounds, except where separate reference to the compound is made. Releases to air may also be released to land or water, depending upon the abatement technology employed, e.g. via collected dusts, sludges or liquors.																

Table 1.2: Potential release routes for prescribed substances and other substances that may cause harm part 2 of 3

Part 2 of 3 - Iron and Steel, continued																
SOURCE RELEASES	Ladle treatments	Relading and recarburisation	Degassing	Decarburisation	Electroslag remelting	Vacuum induction melting	Induction melting	Ferro master alloys	Ferrous alloy powders	Continuous casting	Ingot casting	Scarfing	Slag processing	Skull burning	Rolling mills	Acid pickling
Oxides of sulphur	A						A						A			
Oxides of nitrogen	A						A									A
Carbon dioxide	A	A		A			A					A				
Carbon monoxide	A	A		A			A									
Hydrogen chloride																Aw
Hydrogen fluoride	A				A											
Hydrogen sulphide													A			
Ammonia																
Oxides of iron	A	A		A	I		A			AwI	AI	AwI	wI	AI	wI	wI
Alkali metals													wL	AL		
Alkaline-earth metals													wL	AL		
Metal oxide particulates										AwI	AI	AwI	wI	AI	wI	wI
Non-metallic particulates													wI			
Metallic iron			I						A				wI			wI
Inorganic fluorides																
Hydrogen cyanide																
Cadmium and cadmium oxide			WI	A	I											
Zinc, lead and their oxides			wI	A	I					AwI	AI	AwI		AI		
Other metals and their oxides	A	A	wLI	A	LI				A	AwI		AwI		ALI	wI	
Phosphorus compounds	A															
Sulphur													wI			
Carbon																
Other inorganic chemicals	A														AwI	Aw
Oils and greases										w					AwI	
Slag waste	LI	ALI	I	LI		LI	LI			LI	LI		LI	LI		
Sludges												wI				
Refractory waste			I	LI	LI	LI	LI			LI	LI		LI			
Dioxins																
Volatile organic compounds															A	
KEY	Main polluting substances (defined in Schedule 5 of SI 2000 No 1973):					A – Release to Air, W – Release to Water, L – Release to Land										
	Other substances which may cause harm:					a – Release to Air, w – Release to Water, I – Release to Land										
Substances include their compounds, except where separate reference to the compound is made. Releases to air may also be released to land or water, depending upon the abatement technology employed, e.g. via collected dusts, sludges or liquors.																

Table 1.3: Potential release routes for prescribed substances and other substances that may cause harm part 3 of 3

Part 3 of 3 - Coke												
SOURCE → RELEASES ↓	Charging emissions	Tops leakage	Door leakage	Pushing emission	Coke oven flue gas (battery chimney)	Emergency venting	Emergency flaring	Ammonia incinerator tail gas	Effluent treatment discharge	Effluent treatment sludge	Sulphur and scrubber liquor removal and desulphurisation	Decanters and storage tank vents
	Particulates	A	A	A	A	A	A	A	A			
Sulphur dioxide				A	A		A	A				
Hydrogen sulphide		A	A	A		A						A
Oxides of nitrogen				A	A		A	A				
BTX (Benzene Toluene Xylene)		A	A	A		A					A	A
Volatile organic compounds	A	A	A	A	A						A	A
Phenols		A	A	A		A					A	A
Methane		A	A	A		A						A
Carbon monoxide	A	A	A	A		A						
Tar fume		A	A	A		A	A	A				
Hydrogen cyanide		A	A	A		A						A
Suspended solids									w			
Ammonia	A	A	A	A		A			w			
Cyanide									w			
SCN									w			
Metals									W	I	I	
Sulphur											I	
KEY	Main polluting substances (defined in Schedule 5 of SI 2000 No 1973):				A – Release to Air, W – Release to Water, L – Release to Land							
	Other substances which may cause harm:				a – Release to Air, w – Release to Water, I – Release to Land							
Substances include their compounds, except where separate reference to the compound is made. Releases to air may also be released to land or water, depending upon the abatement technology employed, e.g. via collected dusts, sludges or liquors.												

1.7 Technical overview

Summary of the activities

This Part provides a brief summary of ferrous metals and coke production. Details are provided in the BREF. This is an established sector and few new plants are likely to be built.

1.7.1 Installations in the United Kingdom

Table 1-4 provides an indication of the existing number of sites in the UK covered by this Note.

Table 1.4: Sites producing coke, iron and steel in the UK (2000)

Integrated iron and steel works	3
Merchant and other coke works (i.e. not at integrated works)	1
Electric arc furnaces with furnaces with a capacity of 7 t or more	12

1.7.2 Process routes

The majority of crude steel made in the UK is produced by the blast furnace/basic oxygen steel making process method (BF/BOS). Plants that operate this process route integrate the associated upstream and downstream processes and are known as integrated works.

1.7.2.1 Integrated iron and steel works

Integrated iron and steel works

An integrated works comprises of several separately identifiable processes, which are carried out as sequential operations on a single site, to convert iron ores and other raw materials into semi-finished steel products, such as slab, bloom or billet, and a variety of finished products, including plate, sections, bars, rod, hot and cold rolled sheet and coil, together with various types of coated flat products. There are 3 integrated works in the UK, all operated by Corus UK Ltd. They are listed in Table 1-5.

Table 1.5: UK integrated iron and steel works (2002)

Works	Capacity (Mt/y)	Products
Port Talbot	3.5	Hot rolled, cold rolled and coated strip
Scunthorpe	4.4	Plate, section, rod and other engineering products
Teesside	3.7	

An overview of the process routes indicating inputs and waste streams is given in Figure 1-1.

The main features of existing UK integrated iron and steel works are as follows:

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Loading, unloading and handling of bulk raw materials

Loading, unloading or otherwise handling or storing more than 500,000/year of iron ore is a prescribed process. Plants at Port Talbot and Teesside include deep-water ports handling iron ore and coal. Scunthorpe is supplied from the port at Immingham.

Blending and mixing of raw materials

Iron ores have to be blended before feeding to a sinter plant. This can involve layering blend components on a stockpile and then barrel reclaiming. Coking coals have also to be blended before use to obtain the correct carbonising and coking properties.

Sintering of iron ore

A blend of fine iron ores, additives, iron bearing recycled materials, coke breeze and limestone is blended and a layer circa 400-600 mm deep passes along a travelling grate (called a sinter "strand"). These range in area from 120 to 336 m². A canopy of gas burners ignites the coke and then it passes down the grate, with combustion air drawn down through the bed into suction windboxes. The combustion front is drawn down through the mix as it progresses, peaking at about 1300 - 1480°C, to fuse the fine particles into porous clinker termed 'sinter'. It is subsequently cooled, crushed and screened.

Production of blast furnace coke

Coke is required to act as a reductant and provide a porous matrix structure in the blast furnace. Coke making is undertaken in narrow slot ovens in batteries of up to about 80 ovens. The ovens are arranged alternate with combustion chambers and flues to provide heating. COG, BOS or BF gas may be used to provide heating. UK coke ovens are about 0.3 - 0.6m wide and up to about 6m high, taking up to about 30 t of dry coal. They are top filled from a coal charging car and sealed for a carbonisation time of circa 17 - 25 h (depending on coal properties and carbonisation temperatures). Target average carbonisation temperature (measured in the flues) for a blast furnace coke would typically be about 1200 - 1300°C, with specific requirements for the temperature profile across the flues from ram-side to coke-side. At the end of carbonisation, doors are removed at each side, with a ram used to push the coke from the oven into a coke car which takes it to a quench tower. After quenching with a water deluge, the coke is screened. Gas from the ovens is cooled and cleaned in a by-products plant before use on site. The by-product plant produces useful oils and water requiring treatment before disposal.

In 2004, Corus announced that they are considering building a new set of "non recovery" coke ovens at Port Talbot. Such ovens operate at negative pressure thereby reducing fugitive losses. All of the off-gas is burned on-site to provide heat and power. This process is an established technology in the USA.

Production of molten iron by the blast furnace route

Blast furnaces in UK plants range in hearth diameter from 8.3 to 14 m. These hearth diameters correspond to capacities of 14,000 to 62,500 t/week of molten iron, known as hot metal. Iron bearing materials (iron ore lump, sinter and/or pellets), additives (slag formers such as limestone) and reducing agents (coke) are continuously fed through the top and flow down through the furnace. Air (the "blast") is heated in hot blast stoves and injected with further reductants (oil and often pulverised or granular coal) through tuyeres just above the hearth and flow upwards for removal at the top. Average blast temperatures range 850 –1250°C. The gas is cleaned in a variable throat venturi scrubber before use elsewhere. If furnace pressure is sufficient (circa 2 bar gauge) then a pressure reduction turbine can be used to generate electricity – as at Teesside. Hot metal is tapped periodically at 1 to 4 tap holes at the hearth. The iron passes along runners and is directed into torpedoes or ladles for transfer to the steel plant. As the iron runs from the furnace floating slag is skimmed off.

Introduction			Techniques			Emissions		Impact
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Ladle desulphurisation of molten iron

The hot metal can be desulphurised when held in a ladle at a desulphurisation station by injecting with magnesium-based or other fluxes to form a slag.

Production and refining of steel using the basic oxygen process

The hot metal contains about 4% carbon that has been absorbed from the coke. Much of this carbon must be removed, along with other undesirable elements, to produce steel, which typically contains less than 1% carbon.

A UK BOS plant will have 2 or 3 converters, each with a capacity of 189 - 340 t (liquid steel at tapping). The BOS process is semi-continuous with a complete cycle taking about 45 minutes. Initially, the empty converter is charged with scrap and hot metal. It is then blown with oxygen through a lance to start the exothermic process of oxidising carbon and removing impurities as a slag. Further scrap and iron ore are added to control the temperature at 1600 - 1650°C. Additives are used to aid slag formation. Control is achieved by taking a hot metal sample for on-line analysis, monitoring temperatures and gas pressures, audiometry and offgas composition. The variable throat scrubber has to adjust to maintain an adequate pressure drop for effective cleaning. When the desired steel composition has been reached the oxygen lance is removed and converter tipped to pour liquid steel into a ladle for transfer.

Ladle treatment of steel and other secondary steel making practices

The liquid steel may undergo secondary treatment before casting comprising one or more of the following:

- mixing and homogenising
- adjustment of chemical compositions to close analysis tolerances
- temperature adjustment in preparation for the downstream casting process
- ladle arc furnaces for temperature control and other additions, including lead for leaded steel
- deoxidation
- removal of undesirable gases such as hydrogen and nitrogen
- improvement of the oxide purity by separating non-metallic inclusions

Continuous casting

All UK plants use continuous casters where the liquid steel is poured into a tundish feeding a water cooled mould and a series of cooling/shaping rollers and sprays. The continuous strand is then ready for further shaping into final products. Typically this involves one or more of rolling, reheating, cutting and surface treatment operations.

Treatment and handling of iron and steel making slags

Blast furnace slag is usually collected in slag pits to cool and solidify. It may be used as an aggregate, filter media and other such applications. Hot slag can also be pelletised or granulated, which avoids odours, but there is a limited market for the product in cement.

Slag from the various steel making processes is collected in slag pots. The slag is usually tipped hot into slag pits where it is cooled with water sprays. Residual metal can then be recovered for recycling by crushing, screening and sometimes cutting with an oxyflame torch. Steel making slag can be used as an aggregate and in agriculture as a liming agent.

1.7.2.2 Electric arc furnace steel making

Electric arc furnaces

Electric arc furnace steel making is chiefly used in the UK for high alloy, stainless, bearing and other high quality steels using ferrous scrap. The use of scrap tends to preclude the production of low residual steel (as obtained from the integrated route) unless a source of clean iron is introduced.

Typical UK EAF plants falling under this Note are in the range of 7 to 165 t capacity. The main processes can usually be split into the following categories:

Raw materials handling and storage

The main raw material is ferrous metal scrap. This is supplied in a range of industry standard grades, which limit contaminants such as plastics and oils and proscribe contaminants such as PCBs and radioactive material. Scrap is inspected on arrival and screened for radioactive contamination. Other raw materials are fluxes (e.g. limestone), carbon, alloying additions, deoxidants and refractories. Scrap may be stored outside on impervious surfaces but other materials will normally be kept under cover.

Furnace charging and melting

Scrap is usually loaded into baskets with limestone or dolomite fluxing agent. The electrodes are raised to the top position and furnace roof swung away from the furnace to allow the basket to be charged. Typically 50 - 60% of the scrap is charged in the first basket. Then the roof is closed and electrodes lowered. At 20 - 30 mm above the scrap they strike an arc. Power is kept low initially while the electrodes bore into the scrap. Additional heat is supplied usually by oxy-fuel burners. When the electrodes are fully shielded by the scrap then power can be increased. When the first charge has melted then additional scrap is added from a second or third basket. Oxygen is usually introduced through a lance or port in the furnace to remove carbon and other undesirable elements such as phosphorus, manganese, silicon and sulphur. It also increases productivity. Offgases are emitted through a duct in the furnace roof and passed through a cooler (or scrap preheating stage) and dust collector before emission to atmosphere. Addition of carbon to the bath increases yield by bringing FeO out of slag, helps energy by creating foaming slag, protects furnace structure and muffles noise.

Steel and slag tapping

Slag may need to be removed during heating and oxidising at the end of the heat prior to tapping. The furnace is tilted backwards and the slag run off or raked into a pot. Steel is tapped by tilting the furnace forwards or through a bottom tapping system (except in the case of stainless steel where bottom tapping is technically unacceptable) and run into a ladle. In plants without separate secondary metallurgical facilities, alloying elements and other additions are often given to the steel ladle before or during tapping, causing fume emission.

Secondary metallurgy

This is typically undertaken at ladle treatment stations employing an electric arc system to adjust the temperature of the heat. A vacuum generation system may also be employed to degas or decarburise the molten steel, (see Figure 10.4 of BREF).

Slag handling

Slag is collected in pots and tipped outside. The tipping operation can cause a significant cloud of dust. Subsequent handling of cooled slag can also give rise to dust generation. The nature, quantity and significance of the dust emission is process and site specific. Enclosure of the tipping operation may be necessary in situations where air quality is adversely affected or public complaints arise.

Note radioactive substances are covered by the Radioactive Substance Act 1993 and not IPPC

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Casting

The liquid steel is usually cast continuously from a tundish feeding a water-cooled mould from which a semi-solidified strand of steel is drawn by powered rollers. A continuous strand in the form of a slab, bloom, billet, beam blank or strip is produced which can be delivered directly to subsequent rolling operations, thus minimising energy use in re-heating. Some grades of steel are cast directly into ingots. The steel will then be further processed by re-heating, rolling, cutting and surface treatment.

1.7.2.3 Other process options

Iron ore pellets are commonly used in UK blast furnaces, as a small proportion of the feed, as an aid to controlling burden permeability. It is most economic to produce these at iron ore mines, i.e. overseas.

Other process routes can produce iron, though these are not currently employed in the UK. Where cheap natural gas is available it is possible to produce directly reduced iron (DRI). DRI can form up to 80% of the feedstock for some EAF plants overseas. DRI can also substitute for scrap fed to BOS plant. Alternatively, coal can be used in a reactor to smelt iron. The COREX process has been demonstrated in South Africa, India and Korea at 300 - 750,000 t/a scale. Other smelting reduction processes in development include: HIs melt, DIOS, AISI-DOE/CCF and ROMELT.

1.7.2.4 Coke manufacture

Coke manufacture

Manufacture of blast furnace coke was summarised under Section 1.7.2.1. This is the main application. Two other applications are:

Foundry coke

Produced in similar slot ovens as blast furnace coke but using different coals in the blend (and including coke breeze) and different carbonising conditions. Foundry coke is produced with flue temperatures of 1000 - 1100 °C to give particular coke properties suitable for foundries, e.g. large size. Until recently, foundry coke was produced by Cwm Coking Works (Coal Products Limited) and the Grange battery at Port Talbot (Corus UK Ltd). However, both have now shut.

Domestic and industrial coke

The Monckton Coke and Chemical Company, at Royston, make domestic and industrial coke. Coal and carbonising conditions (circa 1000°C) are selected to suit market needs but are similar to other coke ovens in the sector.

Environmental management of these two applications is very similar to blast furnace coke operations, except that merchant batteries may have a little more flexibility in their schedule to run an undercarbonised charge for longer; the coke is produced at lower temperatures (giving slightly less fugitive fume); and the Monckton batteries have fewer ovens. Effluent treatment requirements are the same.

1.7.3 Environmental effects

Operations producing coke, iron and steel are major users of raw and recycled materials, energy and water. In 1999, the UK iron and steel sector used 18.7 Mt of iron ore, 5.8 Mt of steel scrap, 5.4 Mt of coke and 3.5 Mt of fluxes (dolomite, lime and limestone) to produce 16.3 Mt of crude steel.

Coke, iron and steel production, and associated docks and bulk handling, are significant sources of pollutants emitted to air, water and land. Some of the most significant potential releases in this sector are summarised as follows:

- **Sinter plants** – releases of particulate, heavy metals, sulphur dioxide, nitrogen oxides, carbon dioxide and PCDD/F.
- **Coking plants** – releases of particulate, sulphur dioxide, nitrogen oxides, raw COG, benzene and PAHs to air; oils and wastewaters containing phenols, cyanides and ammonia.
- **Blast furnace iron making** – releases of iron fume (particularly if no cast house fume abatement), carbon monoxide, sulphur dioxide and carbon dioxide to air; and waste water containing iron and heavy metals. Bleeder openings can be noisy and release carbon monoxide and particulate.
- **Basic oxygen steel making** – releases of iron fume, heavy metals and carbon monoxide if they escape collection; and carbon dioxide.
- **Reheat furnaces and on-site power plants** – releases of sulphur dioxide and nitrogen oxides, particularly where burning fuel oil.
- **Electric arc steel making** – releases of iron fume, other metals, PCDD/F and carbon monoxide into air; waste water; fume dust to landfill; and potentially noise from the EAF and materials handling.

Emissions of sulphur dioxide and dust from some integrated works can have a significant impact on local air quality.

The National Atmospheric Emissions Inventory for 2001 suggests a total emission of 357g I-TEQ of PCDD/F from all sources in the UK, of which 40 g (12%) is from the iron and steel industry. Sinter plants are a significant contributor to the overall PCDD/F releases. Two sinter plants at the Corus Llanwern site closed in July 2001.

Sulphur and nitrogen releases from the sector make a small contribution in terms of acidification.

The iron and steel sector is an important recycler of materials. All the ferrous scrap arisings in the UK is recycled, the bulk of it by the UK steel industry. Some 40% of new steel in the UK is made from scrap. By-products produced by the industry are used to substitute for primary raw materials, examples being slags which are processed into roadstone and surplus gases used to generate electrical power for the National Grid. Sinter plants utilise large quantities of internally recycled ("revert") material.

Integrated works recover and use fuel gases produced in coke, iron and steel making. Those gases are used in coke production, heating blast furnace air, in furnaces and production of steam and electricity. Coke, iron and electric steel making are major energy consumers.

Integrated iron and steel works have dedicated landfill facilities on site.

1.8 Economics

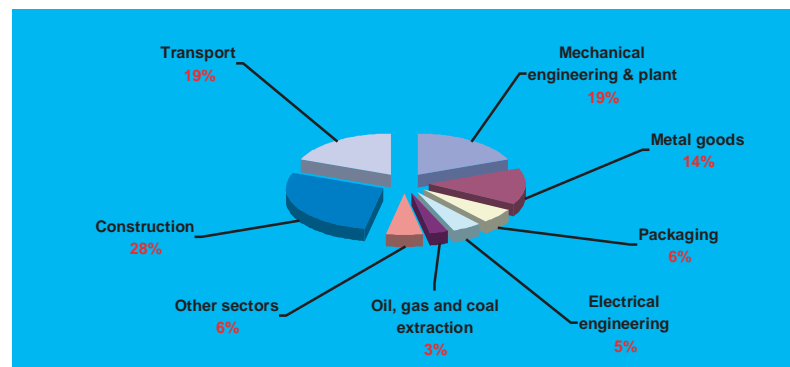
Total crude steel production in England and Wales in 2002 was 11.7 Mt, of which about 77% was produced by the three integrated blast furnace/basic oxygen steel works owned by Corus UK and around 23% was produced by the electric arc furnace process route, including Corus. In 1999, total steel production in the EU was 159 Mt.

UK steel production tends to be cyclical, with the last trough at 16.2 Mt in 1992 and the last peak at 18.5 Mt in 1997. However, a major restructuring of Corus UK operations in early 2001 has led to a reduction in UK capacity. Future UK output and product mix will depend on production structure and market factors. In 2002, the UK exported about 50% of production and 75% of exports went to other EU countries. Some important factors are as follows:

- a surplus in world production capacity
- economic status and changing nature of the UK, EU and global markets
- pressure on steel prices, which are cyclic
- exchange rates (particularly pound/euro and dollar)
- raw material (including energy) and production costs (including employment costs per head and environmental)
- taxation, including the Climate Change Levy
- structural issues (e.g. mergers, such as British Steel with Hoogovens of Holland to become Corus in 1999; membership of the euro; and accession of former Eastern European steel producers to EU);
- competition on non-price factors

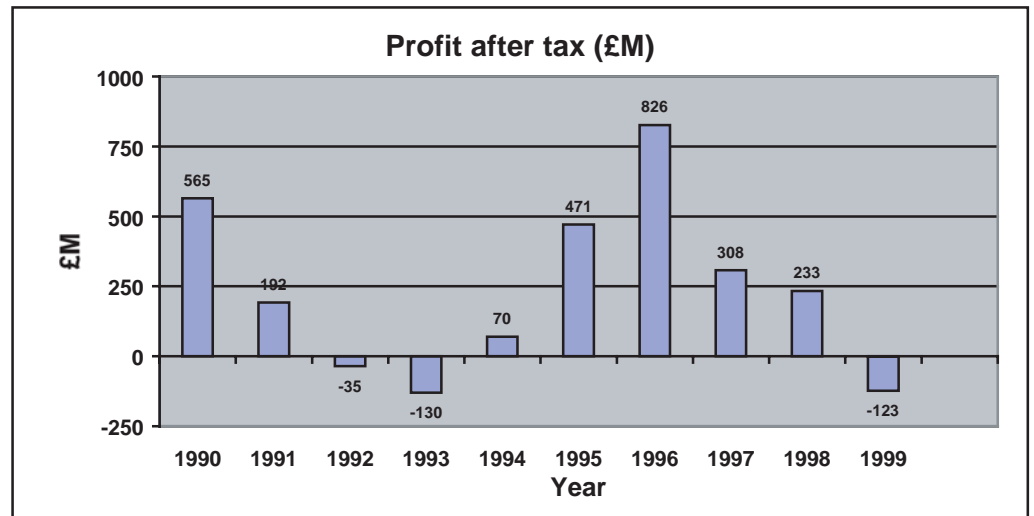
The main domestic steel markets are summarised in Figure 1-2.

Figure 1.2: Main domestic markets for UK steel production (1998, UK Steel Association)



The UK steel industry is one of the most efficient in the world. It has undergone extensive restructuring over the last 20 years and this continues into early 2001. UK steel productivity has risen from 123 t/employee in 1978 to 604 t/employee in 1999. In 2002, 19,400 were employed in steel production.

Figure 1.3: British Steel (now Corus) Profit after Tax (Steel Times March 2000)



Steel prices and profits of the producers tend to be cyclic. For example, Figure 1-3 illustrates the cyclic trend in profit of British Steel (now Corus UK).

Integrated works have tended to run continuously in the past but some electric arc plant may be operated intermittently in response to the order book.

Production of coke in the UK has declined from 38 works in 1975 to 4 in 2002. The majority of coke production is now at three integrated works but there is one merchant plant in the UK. All are subject to economic pressures analogous to steel works. There is a surplus of world capacity, markets are under pressure, they tend to buy coal in dollars and sell in pounds or euros; costs are mainly fixed; and intermittent operation is not practical.

Thus, determining BAT, and in particular implementation, should take account of the economic pressures on the sector and the long timescales to recover investment in capital-intensive equipment.

1.8.1 Economic information

Some indicative economic benchmarks are given in Table 1-6, to assist in assessing economic appraisals.

Table 1.6: Economic benchmarks (2002)

Benchmark	Price (£/t)	Comment
Iron ore	26-32	Landed in UK
Limestone	5	Ex works
Coking coal	30-45	Landed in UK
Steel scrap Old No. 1	25-39	Benchmark for BOS and EAF. Price delivered to mill
Blast furnace coke	45-70	Ex works
Foundry coke	100-120	
Industrial coke (40-90 mm)	70-75	
Domestic coke	70-75	
Integrated works products Hot rolled steel coil Cold rolled steel coil Hot dipped galvanised coil Structural sections Quarto plate	145-215 207-282 272-342 190-245 199-234	Ex mill 2-3 mm thick. Widths > 1100 mm – edges untrimmed, dry coil 1 mm thick. Widths > 1300 mm 1 mm thick. Widths > 1100 mm Shapes having a leg length > 180 mm Produced on reversing mill. 15-40 mm thick. Width > 2 m.
EAF works products Reinforcing bars Merchant bar Wire rod Cold rolled stainless steel 304 type	150-195 150-190 185-205 760-880	Ex mill Deformed bar. High yield grade. 16 – 20 mm dia. in straight lengths 50 mm dia. Straight lengths. Drawing quality. 5 mm dia in full coils. 1.5 mm thick. Width > 1250 mm. Surface finish type 2B. Excluding any alloy surcharges.
Blast furnace rebuild	£75M	Port Talbot blast furnace No 5 January 2003
Blast furnace rebuild	£19-27M	Llanwern Blast Furnace No 3
Steel prices supplied by MEPS (Europe) Ltd. Representative of prices to regular large/medium size customers. Low – high over last 2 years, i.e. representing last price cycle. Peak was mid/late 2000. Further economic information available from web sites of UK Steel Association, Corus Group and other operators.		

Recovering the cost of an investment in this sector is likely to be over an extended period. For example, a blast furnace reline may last for some 10 - 14 operating years (depending on size, design and operating practice). Similar timescales are appropriate for some integral environmental investments and require strategic co-operation between Regulator and Operator.

Indicative costs for a range of possible environmental improvements are given in Table 1-7. Site specific factors and scale will have a major impact on costs. A particular installation will only require some of the improvements listed.

Introduction			Techniques			Emissions		Impact
Understanding IPPC	Making an application	Installations covered	Timescales	Key issues	Summary of releases	Technical overview	Economics	

Table 1.7: Indicative cost guides for environmental improvements

Improvement	Scale	Capital cost	Operating cost	Comment
Sinter plant				
Fabric filter	1 Mm ³ /h & 4 Mt/a	5-15M Ecu1996	0.25-1.5 Ecu1996/1000 m ³	Cost factors: pressure drop, waste gas flow, fabric and filter loading
ESP - Moving Electrode Electrostatic Precipitator	500,000 m ³ /h	1.1M Ecu1997		Additional MEEP
Coke making				
Staged combustion		-	-	As part of a battery rebuild
"Smokeless" coal charging car		£2M	-	4m ovens
Integral hood on coke guide and remote abatement (bag filter)	Llanwern No. 3: 4.2m battery	£12M	£91,000	BPEO study ¹ 1996.
COG Desulphurisation	45,000 m ³ /h COG @ 8 g H ₂ S /m ³	4.4-6M Ecu1996	Ecu1996/1000 m ³ 2.25-3.3	Excludes S credit @ 0.3-0.6 Ecu1996/1000 m ³ 95-99.5% H ₂ S removal
Stretford process	30,000 m ³ /h COG @ 6 g H ₂ S/m ³	19.3M Ecu1996	-	>90% H ₂ S removal
Vacuum carbonate process				
Add denitrification to existing nitrification water treatment system	600,000 t coke/a	0.6 M Ecu1996 (total 4.6M Ecu)	0.57 Ecu1996/t coke	Includes taxes.
Blast furnace iron making				
Direct injection of reducing agents	10.8 m dia. furnace	24M Ecu	Significant saving in coke	No 4 Blast Furnace @ Port Talbot
Top gas energy recovery				3-10 year payback, depending on pressure and energy costs
Hot stove energy savings	Per furnace	6M Ecu1997	0.5 GJ/t hot metal	
Cast house fume control	1 Mt/a furnace	4M Ecu1997	-	Scunthorpe
Wastewater treatment - 2 stages: solid separation & pH correction	3 Mt/a plant	18M Ecu1996	-	Hoogovens IJmuiden
Hydrocyclonage of BF sludge	20,000 t/a	2 M Ecu1994	25 Ecu/t	3 stage plant
Basic oxygen steel making				
Fume extraction & abatement for iron desulphurisation	30-40,000 m ³ /h	10M Ecu1996	-	
Electric arc furnace steel making				
Scrap preheating (shaft furnace)		£1.8M ²	Some saving	Additional costs of Fuchs Finger Shaft Furnace ³ .
Post combustion		£2M		
Lignite injection for PCDD/F control	1Mt/y	0.5M Ecu1997		
Continuous monitoring of open top bag houses		£40K	£3.5K/y	Corus data for single ridge vent
EAF dust recycling		£0.7M	Process	Heckett MultiServ Carbofer process
		£1.4M	specific	Briquetting
Zinc recovery from EAF dust	30,000 t/y	£5M		

Introduction			Techniques			Emissions		Impact
Understand- ing IPPC	Making an application	Installations covered	Timescales	Key issues	Summary of releases	Technical overview	Economics	

Notes:

- 1.Note potential economies in using one system for a set of batteries.
- 2.Note retrofit costs are site specific and may be higher.
- 3.May be difficult to retrofit. Requires long production runs at fixed spec.

Introduction		Techniques for pollution control			Emissions			Impact			
Economics	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2 Techniques for pollution control

To assist Operators and the Regulator's officers in respectively making and determining applications for PPC Permits, this section summarises the indicative BAT requirements (i.e. what is considered to represent BAT for a reasonably efficiently operating installation in the sector). The indicative BAT requirements may not always be absolutely relevant or applicable to an individual installation, when taking into account site-specific factors, but will always provide a benchmark against which individual Applications can be assessed.

Summarised indicative BAT requirements are shown in the "BAT boxes", the heading of each BAT box indicating which BAT issues are being addressed. In addition, the sections immediately prior to the BAT boxes cover the background and detail on which those summary requirements have been based. Together these reflect the requirements for information laid out in the Regulations, **so issues raised in the BAT box or in the introductory section ahead of the BAT box both need to be addressed in any assessment of BAT.**

Although referred to as indicative BAT requirements, they also cover the other requirements of the PPC Regulations and those 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 PPC permitting. Where EU Directives such as the Waste Incineration Directive and the Large Combustion Plant Directive are implemented through the PPC regime, the requirements of these Directives may also be included.

For further information on the status of indicative BAT requirements, see [Section 1.1](#) of this guidance or [Guidance for applicants](#).

It is intended that all of the requirements identified in the BAT sections, both the explicit ones in the BAT boxes and the less explicit ones in the descriptive sections, should be considered and addressed by the Operator in the Application. Where particular indicative standards are not relevant to the installation in question, a brief explanation should be given and alternative proposals provided. Where the required information is not available, the reason should be discussed with the Regulator before the Application is finalised. Where information is missing from the Application, the Regulator may, by formal notice, require its provision before the Application is determined.

When making an Application, the Operator should address the indicative BAT requirements in this Guidance Note, but also use the Note to provide evidence that the following basic principles of PPC have been addressed:

- The possibility of preventing the release of harmful substances by changing materials or processes (see [Section 2.1](#)), preventing releases of water altogether (see [Section 2.2.2](#)), and preventing waste emissions by reuse or recovery, have all been considered, and
- Where prevention is not practicable, that emissions that may cause harm have been minimised and no significant pollution will result.

This approach should assist Applicants to meet the requirements of the Regulations to describe in the Applications 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, leakage or malfunction.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.1 In-process controls

2.1.1 Raw materials handling, blending and mixing

Raw Materials

The storage and flow of raw materials for a typical integrated steelworks is shown schematically in Figure 2-1.

Process: Integrated steel works use iron ores from a variety of sources, which are mainly imported by bulk carrier. Where the ore terminal is not immediately adjacent to the steel works, road and/or rail transfer may be used. The materials are stored in the primary stockyard, together with coke, limestone and other fluxes. Coal is normally stored in a separate stockyard from other raw materials, since the inclusion of ore or flux in the charge to the coking oven could damage the oven refractory.

Blending is carried out in a secondary stockyard to maintain a consistent quality of feedstock for the sinter plant and blast furnaces. Direct charge materials for the blast furnaces (e.g. rubble and pellets) are recovered from the primary yard and screened, with the oversize being conveyed to the blast furnace bunkers and the undersize to the blended fine ore bed for incorporation in the sinter mix.

The stockyards traditionally have permeable base surfaces, usually constituted from the material being stored. The stockpiles are formed and reclaimed using specially designed plant and belt conveyors normally transfer the bulk materials.

Note Radioactive substances are covered by the Radioactive Substances Act 1993 not IPPC

The main scrap storage areas for both integrated and EAF plants are traditionally outside in large uncovered compounds on unpaved ground. The Applicant should take account of problems that may arise from the accidental inclusion of radioactive materials in externally supplied scrap metal. Scrap generated within the processes is recycled and where necessary may be cut into manageable sizes by oxygen lancing. The scrap may be loaded into charging baskets or boxes in the scrap yard or may be transferred for short-term temporary storage in the scrap bay inside the melting shop. In the case of EAF shops, the scrap may be preheated prior to charging into the furnace.

Other raw materials, including fluxes in lump and powder form, carbon, alloying additions, deoxidants and refractories, are normally stored under cover. Following delivery, handling should be kept to a minimum and, where appropriate, dust extraction equipment should be used. Powdered materials may be stored in sealed silos and conveyed pneumatically or kept dry and handled in sealed bags.

- Air:** Emissions to air can comprise fine particulate metallic, coal, limestone or other non-metallic matter.
- Water:** If not controlled, deposition of the fine particulate matter, particularly on paved areas and roofs, may result in pick-up during heavy rainfall and run-off to sewer, surface water drains or watercourses. Similarly, particulate will be present in any run-off resulting from dust suppression sprays. There is potential risk of release of oil or chemicals from storage areas for purchased merchant scrap.
- Land:** Potential risks of contamination of land can arise from storage of bulk materials and purchased scrap.
- Waste:** No significant solid waste produced.
- Energy:** Some energy use in conveying, mixing and reclaiming stockpiles.

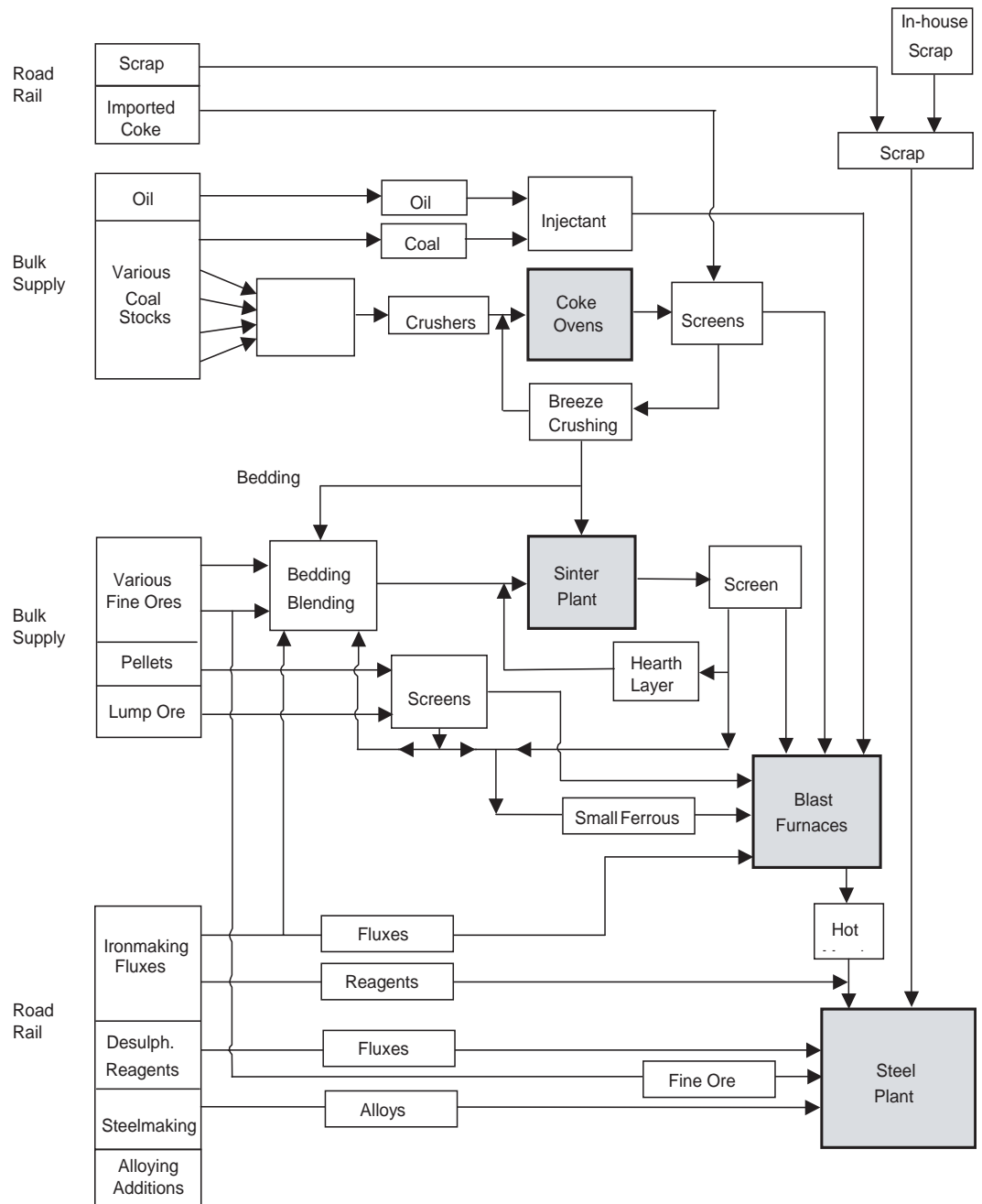
Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Accidents: Accidental release of oil or chemical contaminants from purchased scrap. (Such scrap must be screened for radioactive contamination on arrival at site. This screening may not detect radioactive contaminated material shielded by the load, so some steelworks also monitor for steel, slag and fume dusts at points in the steel making process. It should also be noted that alpha particles are difficult to detect).

Noise: May produce significant impact-derived noise, particularly where scrap handling takes place in the open air. Another common source of noise is the movement and operation of heavy mobile equipment.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Figure 2.1: Typical integrated works materials flow chart



See BREF [Section 2](#) and [Section 4.1](#)

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for raw materials handling, blending and mixing (Sheet 1 of 2)

- 1 In general terms, BAT for the prevention of dust releases during handling of bulk raw materials is the appropriate combination of:
 - orientation of long stockpiles in the direction of the prevailing wind
 - installing wind barriers or using natural terrain to provide shelter
 - controlling the moisture content of the material delivered
 - careful attention to procedures to avoid unnecessary handling of materials and long unenclosed drops
 - adequate containment on conveyors and in hoppers, etc
 - the use of dust suppression water sprays, with additives such as latex, where appropriate;
 - rigorous maintenance standards for equipment
 - high standards of housekeeping, in particular the cleaning and damping of roads
 - use of mobile and stationary vacuum cleaning equipment
 - dust suppression or dust extraction and bag filter cleaning plant to abate sources of significant dust generation
- 2 The following are normally considered to be the BAT for material delivery, storage and reclamation activities:
 - manage stockpile levels so that the drop from the feed chute to the stockpile is minimised, and if fugitive releases are evident then water sprays used to suppress fugitive dust
 - unloading hoppers for dusty materials should either be totally enclosed in a building equipped with filtered air extraction or the hoppers should be fitted with dust baffles and the unloading grids should be coupled to a dust extraction and cleaning system
 - water sprays (preferably using recycled water) should be used for dust suppression;
 - where necessary, storage bins should be fitted with filter units to control dust
 - reclamation from bins should be via totally enclosed devices
 - where necessary, storage of scrap in covered and metalled areas to reduce the risk of ground contamination (using "Just in Time" delivery to minimise size of yard and hence emissions)
- 3 Scrap sorting is required to minimise the risk of including hazardous or non-ferrous contaminants, particularly PCBs and oil or grease. This is normally done by the scrap supplier but the Operator inspects all scrap loads for sealed containers for safety reasons, so at the same time, should check, so far as practicable, for contaminants. Including small quantities of plastic (e.g. as recycled plastic coated components) may be acceptable if shown to have no effect on emissions and is specifically authorised.
- 4 Oxygen lancing of scrap producing significant fume should only be undertaken in areas with fume extraction and collection, or a building which provides the same level of environmental protection.
- 5 With an EAF, any new source of mixed scrap containing non-metallics should be assessed in terms of the likely impact on emissions and, if necessary, a trial batch of scrap should be melted to determine the yield.
- 6 Where fuel and raw materials are delivered by sea and dust releases could be significant, Applicants should use self-discharge vessels or enclosed continuous unloaders. Otherwise, dust generated by grab-type ship unloaders should be minimised through a combination of ensuring adequate moisture content of the material as delivered, by minimising drop heights and by using water sprays or atomised mist at the mouth of the ship unloader hopper. (Seawater should be avoided in spraying ores or fluxes as this results in fouling of sinter plant electrostatic precipitators with sodium chloride).

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for raw materials handling, blending and mixing (Sheet 2 of 2)

7 Powdered carbon and lime should be stored in sealed silos and conveyed pneumatically or stored and transferred in sealed bags. Where carbon material has been recovered from a waste material this should be stated in the Application. Lime and calcium carbide should be kept dry.

Miscellaneous Techniques

8 Where the material being conveyed may lead to significant dust releases, transfer points, vibrating screens, crushers, hoppers and the like should, where necessary be totally enclosed and extracted to a bag filter plant. Central or local vacuum cleaning systems are preferable to washing down for removal of spillage, since the effects are restricted to one medium and recycling of spilt material is simplified.

9 In order to prevent the spread of dust, windbreaks should where necessary be created by natural terrain, banks of earth or planting of long grass and evergreen trees in open areas. This not only has aesthetic benefits, but such vegetation is able to capture and absorb dust without suffering long-term harm. Generally, the technique of hydro-seeding can rapidly establish grass or other appropriate vegetation on waste tips, slag heaps or other apparently infertile ground.

10 Routes used by site vehicles should be planned, where practicable. Points of access from the public highways should be minimised and wheel-cleaning equipment should be employed where necessary to prevent the carry-over of mud and dust on to public roads. Site roads should be surfaced with slag, concrete or tarmac to minimise the generation of dust clouds and vehicles should be restricted to these designated routes by fences, ditches or banks of recycled slag wherever practicable. Water-filled troughs should be used to slow trucks, wash wheels and keep roadways damp. Alternatively, dusty routes can be kept damp with water sprays, e.g. at slag handling operations.

Control of releases to water

11 Run-off of rain water from all open areas, but in particular from ores, coal and raw materials stocking areas, will contain suspended solids. It should be intercepted and the suspended solids removed by settlement or other techniques. Arrangements should be made for monitoring the quality of the water discharged from the storage and blending areas where such discharges are in the vicinity of potentially vulnerable receptors.

12 Areas for handling and storage of purchased scrap are potential sources of contaminated effluent due to leaching of oil and chemicals by rain water. The scrap compound should have an impermeable surface with an appropriate drainage system, including an interceptor trap prior to discharge, unless the environmental risk can be shown to be negligible (e.g. storing clean in-house sourced scrap).

Control of releases to land

13 Applicants should demonstrate that the potential risks of contamination of land by deposition of dust, leachate or run-off water are not significant or make appropriate provisions under Section 2.4. Similarly, they should demonstrate compliance with guidance on groundwater protection, when published.

Control of Noise

14 Heavy mobile equipment should comply with the appropriate standards.

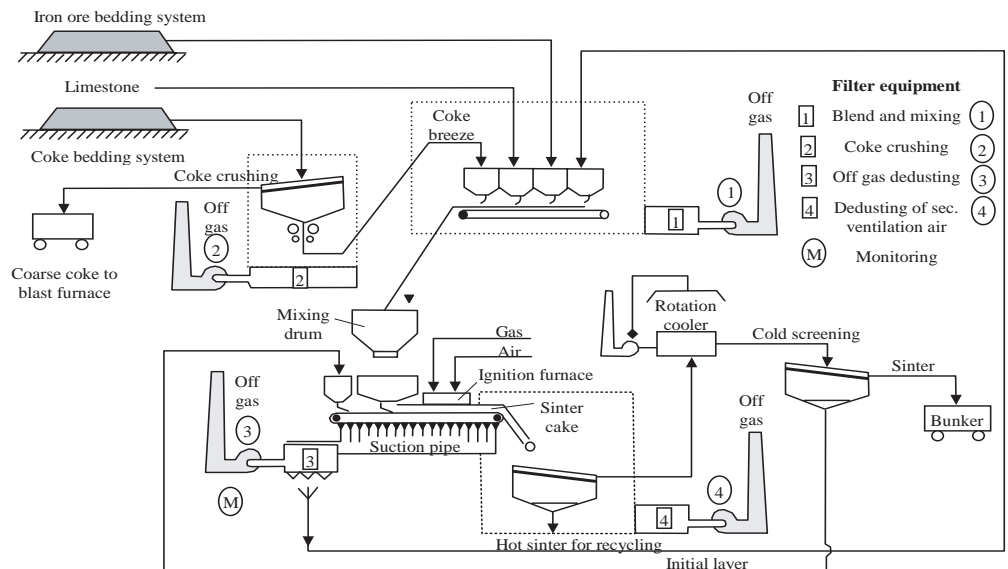
2.1.2 Sintering

Table 2.1: Sintering plants

Works ¹	Strands	Date built/modernised	Grate area m ²	Gross capacity kt/a
Teesside	No 1	1978	336	4,200
Scunthorpe	No 1	1987	305	2,550
	No 2	1988	305	2,550
Port Talbot	No 5	1977	336	3,617

Note: All operated by Corus UK Ltd.

Figure 2.2: A typical sintering plant



BREF Section 4

Process: The sinter plant is used to process iron ore fines and various recycled materials, which are too small to be fed directly into the blast furnace. The sintering process agglomerates the fine material into a clinker-like aggregate, with a size range that is acceptable to the blast furnace. The use of sinter in the blast furnace improves the permeability, homogeneity and chemical composition of the charge, thereby increasing the productivity and consistency of operation and improving the energy efficiency.

In modern sinter plants (see Figure 2.2) the iron ore fines, fluxes and revert materials are deposited in predetermined and weighed proportions on to a fines bed in a chevron pattern, to give the required chemical composition for the sinter feed. Using special machinery and conveyors, the blended bed is reclaimed and transferred to bunkers. Weighed amounts of the blended fines, recirculated sinter fines, crushed coke breeze (to assist ignition and the propagation of the flame front during the sintering process) and burned lime (to improve micro-pelletisation) are passed to a mixing and balling drum (where water is added) to optimise the permeability of the sintering mix.

Sintering is carried out on a continuous travelling grate ("the strand") consisting of a

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

number of individual pallets. These pallets have heat-resistant side plates, with heat-resistant grate bars spanning the strand. The pallets travel over a series of suction chambers (wind boxes), incorporating butterfly valves, so that the volume of air drawn by the main sinter fan(s) can be varied along the length of the strand. This allows the speed at which the flame front is pulled through the sinter mix to be controlled. Beneath each wind box is a dust hopper, which collects the coarse dust drawn through the pallets. After collection, this material is recirculated.

The grate bars on the pallets are protected from the peak temperature of the flame front by a 3-4 cm deep layer of closely sized (15-25 mm), recirculated sinter (hearth layer), which does not contain coke breeze. The hearth layer also helps to reduce the quantity of fine material drawn through the pallets by the suction of the main fan(s).

A roll feeder places the sinter mix from the conditioning drums on to the hearth layer of the sinter strand to a controlled depth, dependent on fan power and plant production required. The surface of the bed is ignited under a gas-fired radiant-hood ignition furnace, producing a flame front, which is drawn downwards through the mix by the suction of the main fan(s) as the bed travels along the strand. Bed depth, strand speed and fan suction are normally controlled to finish sintering (i.e. achieve burn-through) at the penultimate wind box. The agglomerated sinter leaving the strand is broken on a spiked crusher and fed to a circular updraught deep bed cooler. The sinter is discharged from the cooler at about 60°C and crushed to a size range of 5 mm to 50 mm. The product is then screened to remove the undersize sinter and the fraction used as hearth layer, before conveying the oversize material to the blast furnace bunkers.

BREF Section 4.2.2.1

Air: The emissions to air from the sinter plant can represent a major proportion of the overall authorised emissions from an integrated steel works. Particulate matter (heavy metal and iron oxides), sulphur oxides, nitrogen oxides, hydrogen chloride, hydrogen fluoride, carbon monoxide and carbon dioxide are usually released from the main stack. Additionally, trace amounts of organohalogen compounds such as PCDD/Fs, polyaromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) are emitted. A dedust stack emits gases from crushing and screening operations, containing particulate.

For an existing plant, even with well run EPs, it is unlikely that the particulate releases will be less than about 70 mg/m³ from the main stack, which is, in the longer term, unacceptable for such a near-continuous operation. Some existing European plants using bag filters can achieve particulate emission levels of 10-20 mg/m³ from the dedust stack but there are problems of scale, blinding and fires. Given the advantages in collecting a range of substances, it should be the aim to move to barrier filters as soon as the technology permits.

BREF Section 4.2.2.2

Water: Water use is minor. Cooling water is normally recirculated in a closed-loop circuit, which minimises water losses.

BREF Section 4.2.2.3

Land: No effect has been identified as a result of discharges from sinter plants. Bag filtration is a BAT option which would introduce some dust streams; some of which may not be suitable for recycling.

BREF Section 4.2.2.4

Waste: Sinter plants are major recycling centres.

Energy: Significant energy loss in sinter gases, though energy is recovered on some rotary coolers.

Accidents: Not significant.

Noise: Dominant sources are the main waste gas fans and sinter cooler fans.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

BREF Sections 4.3.1 & 4.4

Indicative BAT requirements for sintering (Sheet 1 of 2)

Process control

- 1 Monitoring and control of the quality (including size) and quantities of feedstocks, having particular regard for revert materials.
- 2 Monitoring and control of the sintering process - optimising the process and minimising air in-leakage.
- 3 Minimising strand stoppages as considerable emissions of dust can occur during start-up and shut-down and they cause dust build-up on the EP plates.

Control of releases to air

- 4 For new plants, waste gas dedusting by application of either: (i) advanced electrostatic precipitation (EP) (moving electrode EP; EP pulse system; or high voltage operation EP) or (ii) pre-dedusting with EP followed by barrier filter (currently a bag filter but possibly in future a mesh filter, eg as under development by Parftec Ltd). Operators of existing plants should undertake a BAT review of upgrading to this standard at a time specified in the permit.
- 5 Until upgraded to new plant standard, existing plants should make the best use of existing EPs on the dedust stream through:
 - use of a three or four field EP with high pulsed voltages and on-line cleaning techniques. Careful attention should be paid to airflows (improving baffling fitted where appropriate), maintenance, corrosion, rapping and electrical performance.
 - careful selection of raw materials and recycled materials ("reverts") to minimise deterioration of EP collection efficiency caused by the deposition of alkali metal chlorides on the plates.
- 6 Reducing PCDD/F emissions to a minimum through an appropriate combination of:
 - process optimisation, including minimising stoppages and maintaining consistent operation in terms of strand speed, bed composition (particularly consistent blending of reverts which should not contain significant oil), bed height, use of additions such as burnt lime; and keeping the strand, ductwork, EP and bag filter air tight;.
 - use of urea injection to reduce formation of PCDD/F (subject to successful trials and until bag filter fitted).
 - introduction of bag filtration as final clean-up, with injection of suitable adsorbent, e.g. lignite.
- 7 Reduce SO₂ releases to a minimum through minimising use and sulphur content of the coke breeze; and minimising sulphur content of the iron ore. Plans should be provided to introduce either wet or dry FGD if necessary to meet local air quality standards.
- 8 If local air quality EQS for NO_x are under threat, then use of waste gas recirculation and/or SCR should be considered to minimise emissions of NO_x. However, SCR is recognised as an expensive solution.
- 9 Use of slaked lime coating of the filter bags to protect them from blinding with trace hydrocarbons.
- 10 Bag filter final cleanup would minimise emissions of heavy metals.
- 11 Where practicable, the collected non-metallic dust, the iron oxide dust and the heavy-metal-containing dust and fume should be separated, in order to aid recycling.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for sintering (Sheet 2 of 2)

Control of releases to water

- 12 If wet waste gas treatment is used (which is unusual), the effluent should be treated by precipitation and neutralisation.

Control of releases to land

- 13 Most solid wastes arising from sinter plant operations are recycled within the plant. However, where sludge is produced by a wet gas cleaning system, the feasibility of dewatering and recycling should be assessed. Any disposal to landfill should be justified in the Application.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.1.3 Coke making

Table 2.2: Coke making plants

Works	Battery	Number of ovens	Date built/rebuilt	Output capacity Kt/a (dry wharf)	Doorheight m	Status at 07/2002	Coal charging	Collecting mains	Coke-side abatement
Corus UK Ltd, Teesside									
Redcar	1	66	1984	635	5.36	W	S-less	2	DH
	2	66				W			
South Bank	1	44	1971	305	5.36	W	Seq.	2	DH
	2	44	1972			W			
Corus UK Ltd, Scunthorpe									
Dawes Lane	1	25	1981	240	5.30	W	Seq.	1	None
	2	25				W			
	3	25				W			
Appleby	1	33	1984	185	4.30	W	Seq.	1	
	2	33	1971/99			W			
	3	33	1981			W			
	4	33	1981			W			
Corus UK Ltd, Port Talbot									
Morfa		84	1981	974	6.30	W	Seq.	2	MS scrubber
Monckton Coke and Chemical Company, Royston									
	1	9	1930/75	52.5	4.85	W	Seq.	3	None
	2	9		52.5		W			
	3	8		52.5		W			
	4	16		90		W			
	5	-	N/a	N/a	4.85	No	-	-	-

Coal charging: S-less = Smokeless (i.e. simultaneous, quickly, with no dust emission); Seq. = Sequential.

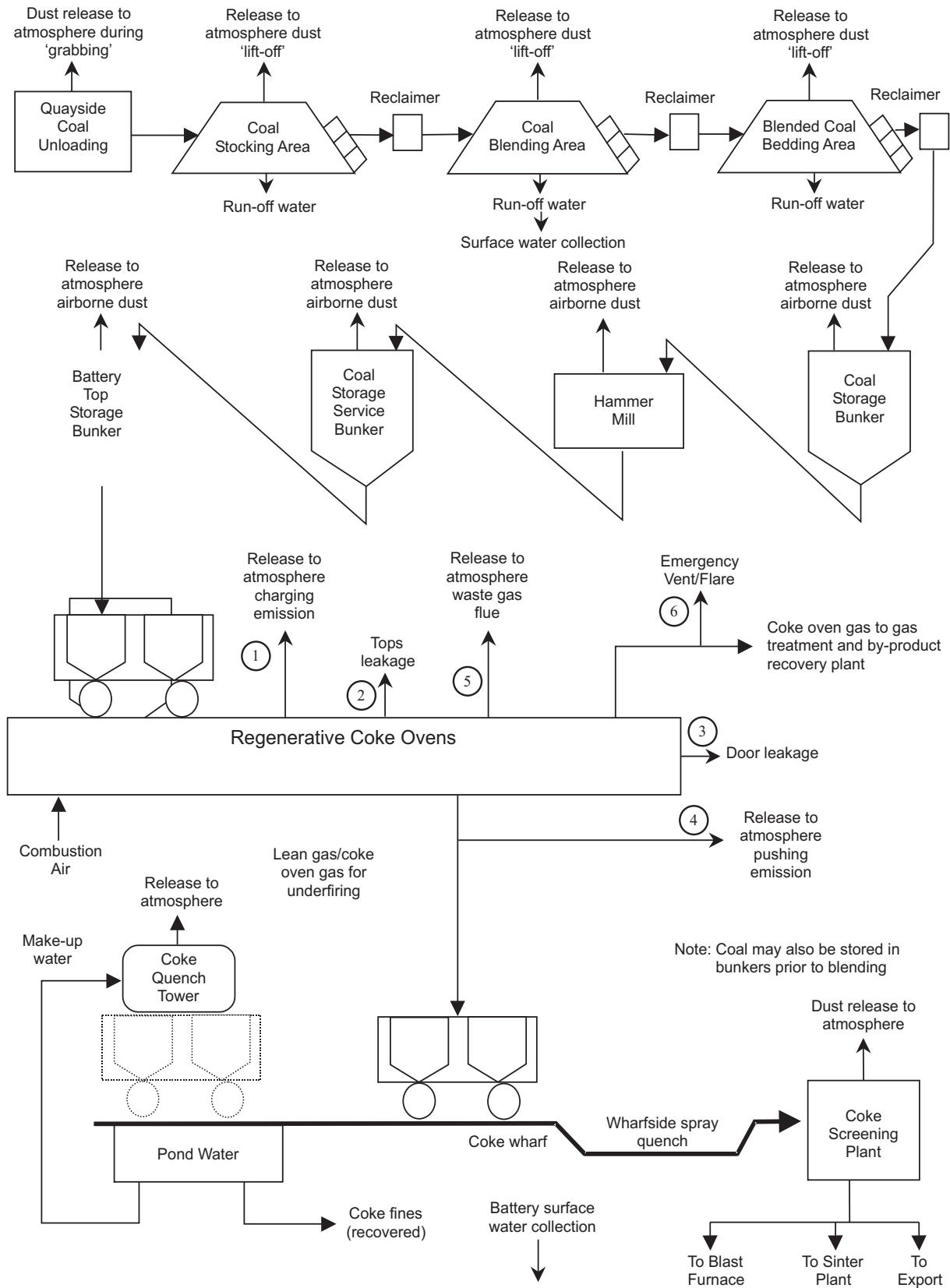
Coke-side abatement: DH= Draught hood; IHRA = Integral Hood on coke guide and Remote Abatement (e.g. Minister Stein)

Low NO_x burners are fitted at Appleby Battery 2 and were used on Llanwern Battery 3.

No batteries have COG desulphurisation.

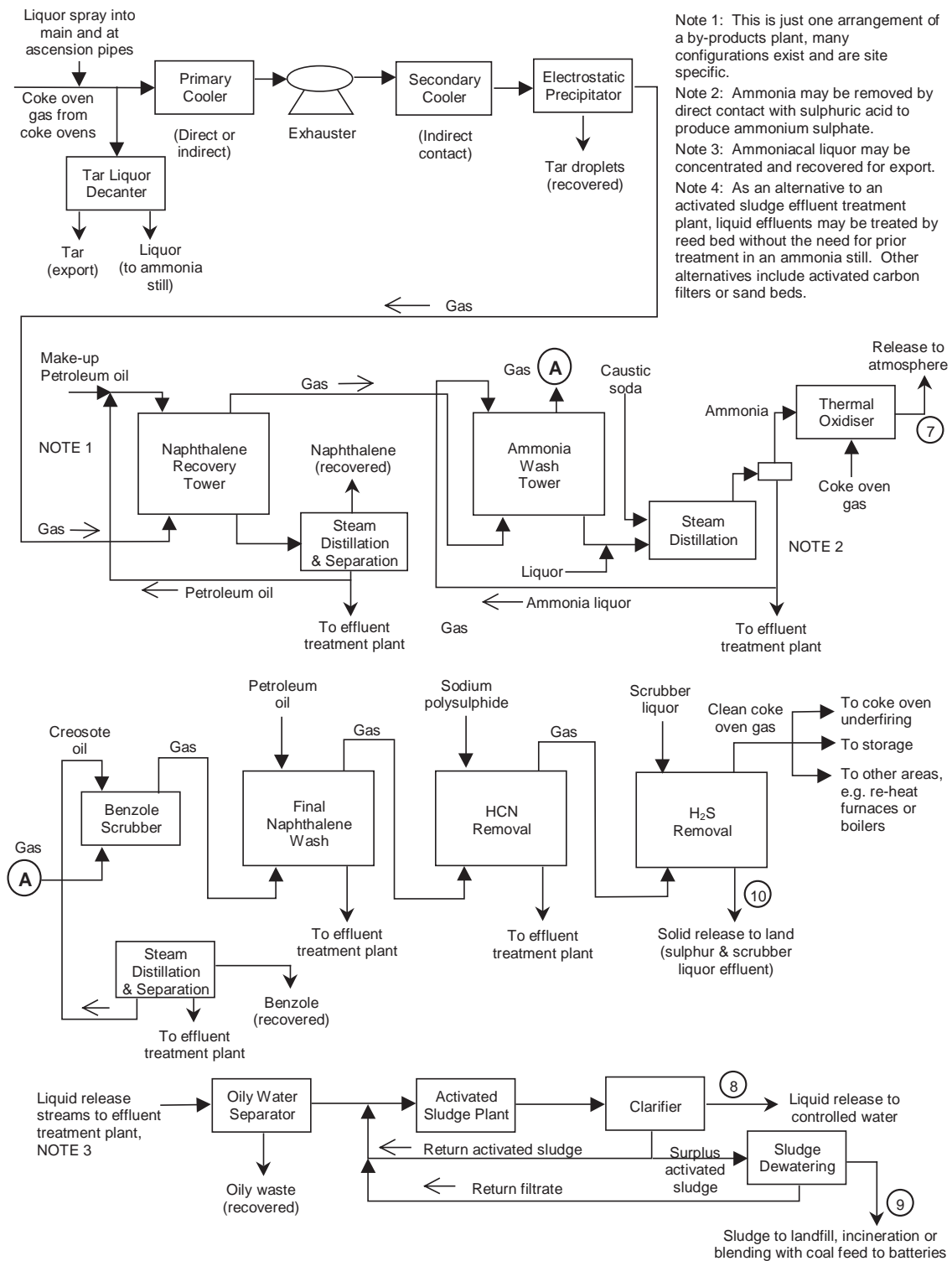
Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Figure 2.3: Schematic of high temperature carbonisation process



Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Figure 2.4: Schematic of high temperature carbonisation gas treatment and by-product recovery plant



Summary of the activities

All coke making processes operated in the UK are high temperature processes (i.e. >1000°C) with similar oven technology. The majority produces blast furnace coke; except Monckton Coke and Chemical Ltd who make industrial and domestic coke.

Simplified schematics of a “typical” coke manufacturing facility are given in Figure 2-3 and Figure 2-4.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.1.3.1 Battery operations

BREF Section 6

All coke oven batteries in the UK are by product recovery ovens, known in North America as “slot ovens”. The slots are formed by walls of refractory bricks and are generally 400-450 mm wide although recent designs have increased this to 650-700 mm. The slots are grouped together to form a battery of up to about 80 ovens, each slot being separated from the next by a series of vertical heating flues extending across the width of the battery and thus providing heat to the two slot ovens adjacent to it. The whole structure is supported and restrained by a steel framework consisting of vertical girders (“buckstays”) and tie rods.

In 2004, Corus announced that they are considering building a new set of “non recovery” coke ovens at Port Talbot. Such ovens operate at negative pressure thereby reducing fugitive losses. All of the off-gas is burned on-site to provide heat and power. This process is an established technology in the USA.

BREF Section 6.1.2

The flues are fired either by coke oven gas derived from the carbonising process itself (‘rich gas’) or a mixture of coke oven gas and blast furnace gas and/or BOS gas (“lean gas”). Flue temperatures of 1000-1300°C are employed and high fuel efficiency is obtained by passing the hot waste gases through a regenerator system under the ovens. Excess heat is given up to the chequer brickwork in the regenerators and subsequently recovered by pre-heating the combustion air (and gas if lean gas firing) which is passed through them. The use of regenerative heat recovery means that a regular change of flow from gas to air is required and flues are therefore linked in pairs with the direction of flow of the combustion gases being reversed at about 20-30 minute intervals. This gives a cyclic pattern to many temperature measurements on a coke oven battery and this should be allowed for when interpreting those measurements. Temperature distribution across the battery is deliberately programmed to correct for the slight taper of the ovens, i.e. wider towards the coke-side to ease oven discharge. Vertical temperatures are also deliberately programmed to allow for variations in coal charge density and other similar factors. Some designs incorporate ‘staged combustion’ at different flue heights to achieve the desired temperature gradient. Waste gases from the combustion flues are led to a common waste gas duct and thence to the battery chimney. Combustion takes place under natural draught controlled by various valves, restrictions and orifices in the air, fuel and waste gas mains.

All UK coke ovens are charged with coal blends without special drying, i.e. typically at 7-13% moisture. Sometimes the coal is coated with oil to increase charge density. Charging is carried out through a series of holes in the top of the oven and the rate and sequence with which these are used affect the initial gas evolution from the charge and may form part of the charging emission control system. The coal is conveyed from a storage bunker, usually located above the end of the battery, to the individual ovens in a charge (or “larry”) car with hoppers designed to feed coal into the charge holes. Coal charging can be a major source of emission of coal dust and fume if slow or if no prevention measures are used.

During and after charging the oven, the coal is normally levelled by means of a leveller bar inserted from the pusher machine through a small door located at the top of the pushing side door. This bar traverses the oven and smoothes the coal charge before it is withdrawn and the leveller door closed. A small emission of tar/volatile fume occurs through the leveller door during levelling. On completion of charging the charge hole lids are replaced and a sealant applied. Significant green volatile fume emission may occur through coke oven door seals at this time, especially if achieving a gas tight seal requires a further step of final (manual) tightening of door seal mechanisms.

The charge remains in the oven until carbonisation, which commences at the hot faces of the two walls and progresses towards the centre, is complete. This can take from 14 hours upwards depending on the temperatures used, geometry of the oven and nature of the coals used. The period of carbonisation, coal blend and flue temperatures are controlled to suit the type of coke being produced. During this time gas is evolved from the charge and is extracted through one or two ascension pipe(s) located at the end(s) of the oven top and leading to the gas collecting main(s) which runs the length of

Introduction		Techniques for pollution control			Emissions			Impact			
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the battery. Ascension pipes are equipped with liquor sprays to cool the gases, valves to isolate them from the collector main, steam or high pressure water jets to create suction in the pipe when necessary and a cap, which can be opened.

When the carbonisation time has elapsed, the oven is isolated from the collecting main and the ascension pipe cap is opened to vent the oven. Evolution of gas can still be significant. In such cases the gases should be ignited (if possible) to avoid a highly visible green plume of fume. (Note: Leakage from the collecting main can contribute to the fume and this should be avoided by adequate maintenance). The pusher and coke guide machines can then remove the doors at each end of the oven. These machines are designed to travel up and down the length of the battery on a track. The pusher machine pushes the coke through the guide into a coke-collecting car. Even with correct carbonising conditions of coal quality, time and temperature profile there is always some emission of dust during coke pushing, e.g. due to coke fissures and slightly lower temperatures at the doors. Areas of low wall temperature will result in undercarbonisation and release of volatiles and coal. Overcarbonisation due to excessive temperature will result in more fissuring of the coke and consequently an increased emission of grey coke dust. Hence, minimisation through attention to temperature control is essential but systems to abate this emission are also available and described below.

The coke car transports the hot coke to a quench tower where water is sprayed on it before it is discharged on an inclined bench known as a coke wharf.

Before the doors are replaced on the two ends of the oven their sealing surfaces are cleaned according to a defined cycle to prevent leakage or, where that is not possible, to minimise it. On older designs the seal may be a knife-edge with spring loading while more recent door designs can feature flexible seals. The oven is then ready for re-charging.

2.1.3.2 Coke handling

The coke wharf is the receiving area for the quenched coke product, adjacent to the battery, typically 100m long and at an angle of 30°, lined with heat resistant brick. The quenched coke is tipped from the quench car on to the wharf and slides under gravity to the collecting and transfer area. Water hoses are strategically sited along the length of each wharf to enable any hot spots in the coke batch to be easily and quickly quenched.

The coke is removed from the wharf by manual gates or a plough (coke feeder) which traverses the length of the coke wharf. The rate of the extraction can be regulated to suit the plant requirements. The handling operation described leads to minimal dust arising and mechanical attrition is minimised to maintain coke quality.

Although the cutting of coke is not always necessary for blast furnace and foundry use, it is necessary for the domestic market. Coke cutters are based on the principle of feeding coke into rotating blades mounted on one or two drums. The cut coke is then screened on a moving screen to separate out the required size range. This primary screening is to remove the fines from the cutting operation.

The screening/cutting operation may lead to significant quantities of dust arising. The operation should be inside containment with the dust arising extracted into a proprietary bag filter unit. Where possible, dust collected in bag filters or wet settlings should be recycled.

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2.1.3.3 Collection and purification of gas and by-products

BREF Section 6.1.3

The following sections outline the collection and purification of gas and by-products. Figure 2-4 illustrates the process steps but the figure shows one particular configuration of by-products processing. Many other configurations are possible.

2.1.3.4 Gas cooling and tar separation

The gas is cooled in several stages to less than 30°C before further treatment. Gas from the ascension pipes at around 850°C enters the collecting main where it is cooled by sprays of recirculating liquor to about 90°C. Most of the tar condenses in the main, which has a sloping bottom to assist the flow of tar and liquor. The gas then passes to a primary gas cooler, which reduces the temperature to about 20-30°C, condensing water vapour and more tar. The combined liquors pass to tar settling tanks from which clarified liquor overflows and is stored before recycling to the plant. The excess liquor contains dissolved ammonia, acid gases and phenols and is treated before discharge from the plant (see next section). The tar is recovered for sale.

Up to this point, the gas is under negative pressure. It now passes to the exhauster, which provides the upstream suction and downstream pressure to drive the gas through subsequent purification stages. Compression of the gas results in a rise in gas temperature. Depending on the requirement of the subsequent stages, the gas may then be cooled to remove the heat of compression in a secondary cooler. Final tar fog removal may be carried out on the cooled gas using electrostatic precipitators.

Adequate pressure control of the battery is important in minimising leakage to atmosphere of fume. Failure of an exhauster can require venting of the batteries through emergency bleeders along the battery top. Hence, there is normally a back-up exhauster. Loss of suction is a serious matter, which can have significant environmental consequences, particularly if the vented gases are not ignited.

2.1.3.5 Gas purification: by-product removal and recovery

Further treatment includes a number of processes to remove and recover impurities from the gas. Naphthalene, ammonia, benzole, sulphur compounds and cyanides can be removed by scrubbing with a suitable solvent, generally referred to as wash oil. The solvent is then treated to regenerate it and to extract the substances, which may require further treatment to render them suitable for sale or disposal.

The configuration of gas treatment systems varies widely from plant to plant depending on specific requirements and plant supplier's design.

Naphthalene and benzole

Naphthalene and benzole vapours (primarily benzene, toluene and xylene or BTX) are scrubbed from the gas using wash oils of coal or petroleum origin. Naphthalene may be removed in a primary washing stage before ammonia removal or in a final stage following benzole washing; or as an intermediate stage between ammonia and benzole removal. The wash oil is regenerated and the components recovered by steam stripping. Naphthalene may be separated or mixed with tar for disposal. Crude benzole may also be processed on site.

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Ammonia

Liquor from the scrubbers passes to steam stripping stills where caustic soda is employed to release the fixed ammonia and associated hydrogen sulphide and hydrogen cyanide gases by raising the pH. It is then cooled and stored for recirculation to the washing circuit. Excess liquor from the tar tank is treated in the same way, either in separate stills or in combination with the scrubber liquor.

Stripped liquor is then used as scrubbing solvent in the ammonia wash tower with any excess being treated to remove the remaining ammonia, phenolic and thiocyanate compounds to make it suitable for discharge from the works.

In some still processes fitted with a de-acidifier, the acid gases are largely separated from the ammonia to be recycled to the gas flow upstream of the ammonia scrubbers. De-acidifiers may be used to provide a desulphurisation capability.

Stripped ammonia and hydrogen cyanide gases are usually incinerated.

Ammonia can be recovered as saleable product from the still by absorption in water to produce concentrated ammonia liquor (CAL) or by cooling, or by contact with sulphuric acid to produce ammonium sulphate.

Sulphur and cyanide

Of the sulphur contained in the coal blend, a variable proportion is released into the gas. This sulphur appears principally as hydrogen sulphide in concentrations depending on the sulphur content of the coal, in the region of 2 - 8 g/m³. Sulphur is also present as organic sulphur compounds (e.g. carbon disulphide, oxysulphide and mercaptans) typically at a level of 0.4 g/m³ expressed as sulphur.

Several processes are available worldwide for the desulphurisation of coke oven gas. Primarily these processes remove hydrogen sulphide and not the organic sulphur compounds. Hydrogen cyanide is also released in this process and may be removed by these techniques. The separate removal of hydrogen cyanide is sometimes – but not normally – practised.

The traditional dry iron oxide process can reduce hydrogen sulphide levels to 10 mg/m³, but is labour intensive and produces spent oxide requiring a waste disposal licence to tip. It was used widely on UK coke plants exporting gas but is now considered obsolescent.

Coke oven gas desulphurisation technology

All available processes fall into two types – absorption/stripping (equilibrium) or wet oxidation (REDOX).

Absorption/stripping processes

The acid gases, hydrogen sulphide and hydrogen cyanide are absorbed by an alkaline scrubbing solution, which is regenerated by stripping. Alkalis used in proprietary processes include sodium carbonate, ammonia and a range of alkanolamines.

The most common type of absorption/stripping processes use an ammonia solution (derived from the ammonia scrubber) and these are the most frequently used desulphurisation processes in Europe. These are the Carl Still, Diamex and ASK (Ammoniumsulphide Kreislaufw-scher) processes.

Other processes are the Vacuum Carbonate (using sodium carbonate to also remove HCN and CO₂); Sulfiban (using monoethanolamine, MEA); and the DESULF process (similar to ASK, but producing ammonium sulphate).

The processes can typically reduce hydrogen sulphide to 300 – 500 mg/m³ or better if a final strong alkali wash is included. Some advanced physical absorption process will achieve significantly lower residual levels of hydrogen sulphide.

BREF End of Pipe Technique EP.7

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The gases are released by steam stripping and treated to dissociate hydrogen cyanide together with any ammonia present. The hydrogen sulphide is then converted to sulphur (99.9% purity) in a Claus plant or sulphuric acid by the wet contact process.

Wet oxidation processes

Wet oxidative desulphurisation (REDOX) is practised in Japan and at some plants in Europe, particularly the Stretford process. Other wet oxidative processes are the Takahax, Thylox, Perox and Fumaks/Phodacs processes.

Hydrogen sulphide is readily absorbed from the gas in an alkaline solution containing a REDOX reagent. Hydrogen cyanide is also readily absorbed in the solution and depending on its concentration in the gas, it could prove economical to scrub most of this component in an upstream process.

The process can typically reduce hydrogen sulphide levels to 10 mg/m³ or less.

Examples of alkalis used are sodium carbonate (Stretford process) and ammonia. REDOX agents employed are organic quinone derivatives, picric acid, multivalent vanadium salts and chelated iron compounds.

The absorbed hydrogen sulphide is oxidised primarily to sulphur by the REDOX agent. A small proportion is oxidised by undesirable side reactions to sulphate and thiosulphate and any hydrogen cyanide absorbed forms thiocyanate.

In most applications of the wet oxidative type process, the inevitable build up of these "fixed" salts in the scrubbing solution is controlled by 'blowing down' a proportion of the scrubbing solution and replacing with fresh make-up. The blowdown may be treated to recover process chemicals or otherwise disposed of. The REDOX catalyst is regenerated by air. The sulphur is separated from the solution by flotation, settlement or other means and then washed and can be recovered for sale, particularly in molten form. Disposal as dry cake to a licensed waste disposal site should be avoided, if possible.

In one variant of the process a side stream is oxidised by air in a continuous flow pressure autoclave which converts all the sulphur compounds to sulphate and sulphuric acid which can be employed in an ammonia saturator.

Treatment/disposal of blowdown

The blowdown is biologically degradable at low concentration levels. High dilution ratio is required such as provided in large-scale biological treatment plants.

Several processes to treat the blowdown and partially recover process chemicals have appeared:

- mixing the blowdown liquor with coal fed to the batteries
- high temperature reduction of the fixed salts by gaseous and/or solid reducing agents to release hydrogen sulphide to be returned to the main gas stream and recover some chemicals which are recycled to the scrubber system
- oxidation by air at elevated temperature and pressure, yielding sulphate. Certain chemicals may be recovered by ion exchange techniques and then returned to the scrubbing solution

The blowdown is otherwise sent to a licensed waste disposal site.

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2.1.3.6 Releases

BREF Section 6.2

Air: The most significant releases to air are illustrated in Figure 2-3 and can be summarised as follows:

1. Smoke, oxides of sulphur, nitrogen and carbon from the battery chimney.
2. Coal dust and volatiles from charging operations.
3. Volatile fume from ascension pipes and caps, oven lids and doors.
4. Dust and/or volatiles from coke pushing and quenching.
5. Fugitive benzene and ammonia from the by-products plant.

Sources 1, 2, 3 and 4 are highly dependent on the expertise and diligence of operating staff and management.

Volatile fume will contain a wide range of pollutants such as hydrogen sulphide and organic sulphur compounds, hydrogen cyanide and hydrocarbons including benzene and polycyclic aromatic hydrocarbons (PAHs).

Water: Water from coal moisture, decomposition and steam injection (where used, e.g. to induce suction in an oven during coal charging) is separated in the by-products plant. Free ammonia is removed by distillation and fixed ammonia by treating with caustic soda. The resulting water contains high concentrations of various organic (e.g. phenol and PAH) and inorganic compounds (e.g. ammonia and cyanides). Specific composition will depend on coal composition and carbonisation conditions. Cooling water is generally used in indirect coolers with closed circuit recycle. Excess quench water is collected and recycled.

Land: The biggest risk is contamination from tar and other organic compounds (e.g. BTX - Benzene/Toluene/Xylene) spilling or leaking to ground around the by-products plant and coke battery.

Waste: The main sources of wastes are sludge from the COG desulphurisation and effluent treatment plant.

Energy: About 67% of the energy input as coal reports in the primary coke product (assuming a coke yield of 780 kg coke/t coal). A surplus of COG is produced for use elsewhere on site or sale. Coke ovens can lose about 3 GJ/t coke in energy losses, i.e. about 8% of the energy content of the coal.

Noise: The principle sources of noise on a coking works are screening operations, fans/blowers and warning sirens on battery machines. These do not normally have an impact off-site.

Accidents: There are many potential sources of accidental environmental release. Notable examples are as follows:

- failure of the exhausters resulting in bleeder operation;
- mechanical breakdown, e.g. of dampers causing black smoke from the battery chimney;
- spillage or leakage at the by-products plant; or
- process upsets which can overwhelm a biological based water treatment plant.

See BREF Sections 6.3 & 6.4

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for coke making (Sheet 1 of 7)

Key principles

- BAT for coke making relies as much on techniques and operation as it does equipment. Prevention of fugitive releases to air and accidental releases to air, water and land are heavily dependent on (BREF PI.1):
 - maintaining steady operation of the batteries
 - well trained and motivated operating staff (and subcontractors)
 - management who use key performance parameters in systematic monitoring and fault analysis (e.g. chimney and fugitive emissions, coke and flue temperatures and battery pressures in the short term; and battery average temperatures and emissions trends over the medium term)
 - a preventative maintenance programme taking environmental risk into account, with appropriate condition monitoring
 - substantial investment in maintaining and refurbishing machinery; rebuilding ovens and flues; and maintaining ducts/joints and plant in the by-products area

Maintenance

- An adequate programme of battery and by-product plant maintenance is fundamental in minimising emissions. Monitoring performance of the battery chimney, ovens and visual inspections will reveal the need for short term measures, such as cleaning oven necks, silica welding of wall leaks, etc. (BREF EP.3)
- As ovens deteriorate with use the following techniques should be used (as appropriate):
 - degraphitising of deposits within the chamber
 - ceramic welding cracks, holes and surface damage to brickwork
 - repair of the oven floor by flooding with cement
 - air born dust injection into the fine cracks
 - complete overhaul of the doors and replacement of refractory material (BREF PI.2)
- Regular maintenance (and availability records where appropriate) should be maintained on all environmentally critical plant, in particular exhausters and by-products plant, charging cars, oven doors, ascension pipes, chimney damper drives and abatement equipment.
- The bracing system of the ovens (springs, anchoring etc) should be regularly checked.
- End-flue and pad-up (i.e. total) rebuilds are necessary as batteries deteriorate. The Regulator should be consulted at the planning stage of major investments, to ensure BAT is being considered.

Control of releases to air from battery operation

Battery chimney

- Particulate matter/smoke emitted from battery chimneys is mainly soot arising from incomplete combustion. This may be the result of poor setting or maintenance of burners but is more likely to result from gas leakage from ovens to flues or in regenerators. The extent to which this occurs depends on the age and condition of the battery as a whole. Adherence to a regular pushing/charging schedule and effective control of oven heating can assist in minimising brickwork damage and hence gas leakage. It is possible to filter or scrub flue gas before release but reduction to a minimum is regarded as BAT. Thus, process fuel gases other than COG (which has been cleaned in the by-products plant) require effective filtration or scrubbing before use. (BREF EP.6 & EP.7)

Introduction			Techniques for pollution control			Emissions			Impact		
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Indicative BAT requirements for coke making (Sheet 2 of 7)

- 8 When fuels containing sulphur are burnt, the sulphur is emitted principally as SO₂ with some SO₃. COG should therefore be desulphurised prior to its use as a fuel, whether fired on the coke oven battery or elsewhere in the installation. Operators of existing coke ovens without desulphurisation and new plant should submit plans for installing it by 2007. (BREF EP.6)
- 9 Emissions of NO_x should be minimised through the following measures:
- fit low NO_x combustion systems at the next rebuild
 - fit SCR of flue gases if the local NO_x air quality standard is under threat. SCR is expensive and is an exceptional solution (BREF EP.2)
- 10 Emissions of CO from the chimney should be minimised through combustion optimisation and in the cellars by adequate maintenance of the fuel gas systems.

Battery tops

- 11 It is essential that battery tops are maintained in a clean and tidy condition, with any spillages removed immediately.
- 12 Charge hole rims and lids should be kept clean to prevent leakage. When they are removed and replaced mechanically by the charge car the twisting motion, which is usually imparted, may be sufficient to achieve this. Some car designs incorporate separate cleaning devices. The lids are usually sealed with clay-water luting or similar sealant after they have been replaced but care should be taken to ensure that the sealant material does not accumulate and prevent good seating of the lid.
- 13 Ascension pipe caps should have a water seal or a dry seal of equivalent effectiveness. Near constant attention is required to ensure a water seal is effective. Reliability can be improved by using flexible water hose connections and wide bore connections. With time, ascension pipes deteriorate so their condition needs to be monitored. Pipes and caps need effective maintenance.
- 14 The aim should be to have no fume escapes from any ovens, and associated ductwork, which are closed and carbonising, though this is difficult to achieve and requires continuous vigilance. Automated continuous fugitive monitoring is not currently possible but a view along the battery top is sufficient. No fumes should be apparent. (CCTV can also provide some assistance). Systematic assessment of leakage should be undertaken using the BCRA Top Leakage Control Factor (TLCF) method. Beside being a good spot assessment, it is an important means of trend analysis of battery maintenance and how much staff attention is being given to this area. (BREF PI.3 & PI.4)

Oven doors

- 15 Oven door gas-tightness is essential and can be achieved by applying the following principles:
- use of spring-loaded, flexible sealing doors (may not be practicable if doors < 5m high, in which case knife edge seals are BAT)
 - effective insulation of door and frame to prevent heat distortion
 - sealing surfaces should be maintained in a clean condition by high pressure water jet or mechanical cleaning when a door is removed
 - regular maintenance of doors in a repair bay will prevent deterioration of seals and correct any mechanical damage

Introduction		Techniques for pollution control			Emissions			Impact			
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Indicative BAT requirements for coke making (Sheet 3 of 7)

16 The aim should be to have no fume escapes from any oven doors, which are sealed and carbonising, though this is difficult to achieve and requires continuous vigilance. Automated continuous fugitive monitoring is not currently possible but a view along the battery is sufficient to identify unacceptable releases. (CCTV can provide some assistance in this). As a quick test, if more than 5% of doors are visibly fuming or any leaks (including from behind frames or buckstays) are large enough to catch fire then attention is overdue. Systematic assessment of leakage should be undertaken using the BCRA Door Leakage Control Factor (DLCF) method. This is an important measure for trend analysis of the quality of door maintenance and how much staff attention is being given to door leakage. (Note that DCLF does not consider leakage from behind doorframes). (BREF EP.1)

Charging operations

17 The charging of coal into a coke oven can result in the release of a highly visible rising cloud of coal dust, though this is completely avoidable under ideal conditions. Emission free charging requires high speed charging, maintaining slight negative pressure or a gas tight seal at the charging hole and leaving a plug of coal, or other form of seal, in the coal feeder at the end of the charging to avoid gas release through the hopper. In the UK, two basic techniques are used:

- “Smokeless” charging relying on gas-tight connections and simultaneous charging through all four holes. Suction is generated by steam or water injection in the gooseneck of the ascension pipe.
- “Sequential” charging of the holes. This takes longer. Suction is created on both sides of the oven through two ascension pipes, or if only one, then a jumper pipe to an adjacent oven should be used. (BREF EP.7 & EP.1)

18 Both approaches are done with the oven connected to the gas collecting main, (i.e. “on the main”). Skilled Operators with well designed high capacity charging equipment and free flowing coal should achieve emission free charging. Wet coal can cause blockages which slow the operation and increase the risk of visible emissions. (BREF EP.4)

19 Operators of batteries which cannot achieve charging with zero or insignificant dust emission, should present plans to achieve it by 2007. “Smokeless” charging is BAT for new or rebuilt batteries.

20 Where steam or water injection at the gooseneck is used to induce suction, Operators should ensure it is functioning before charging commences.

21 Regular degreasing of the oven roof and gooseneck cleaning are necessary to ensure free gas flow.

22 Minimising the proportion of fines in the coal feed has been shown to reduce emissions during charging, where these are significant.

23 Recycling of waste coal or collected oils by thorough mixing with the coal feed is BAT.

24 As a quick check, visible charging emissions (viewed from downwind of the larry car) should be < 10 seconds on “dry” coal and < 30 seconds on “wet” coal. Operatives should assess the emissions from each charging operation (e.g. against a scale of 0 – 4 or in excess of a particular duration) and record excessive releases on an exception basis. A systematic assessment of leakage should be undertaken using the BCRA Mass Emission Factor (MEF) method, including trend analysis of performance.

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Indicative BAT requirements for coke making (Sheet 4 of 7)

Pushing operations

- 25 When coke is pushed from the oven there can be a significant emission. The PPC Regulations require no significant pollution. If the coke is undercarbonised at any point the emission can be greatly increased with dust and volatiles. Conversely, overcarbonisation (principally a risk through excessive temperature) at any point will give additional grey dust emission. Prevention of significant pollution is undertaken in two stages.
- 26 a) Strict control of the carbonising process,
- 27 Particularly of coal quality, temperature profiles and carbonisation time. Applicants should describe their systems for each.
- 28 Coal quality should be monitored to ensure; appropriate blends are used; crushing does not produce excessive fines; and moisture content is managed so far as practical. Carbonisation times should be logged and rigorously policed. But carbonisation temperatures probably require the most attention to keep under control. Routine cross wall flue temperature surveys should aim to meet target temperature profiles (within say 20°C tolerance), with appropriate remedial action taken promptly – e.g. cleaning or adjusting the heating. Statistical averaging should be used to control the overall battery temperature, taking extra care in prolonged periods of wet weather.
- 29 Coal quality control is also important in preventing ‘sticker’ ovens, which cause large smoke and fume emissions and a threat of damage to the oven walls as the coke is removed.
- 30 b) Coke side arrestment
- 31 Coke side arrestment is required for all new plants, rebuilds and existing plants. The BREF describes 5 systems for collecting and abating pushing releases:
- 1 Coke side sheds with evacuation and dedusting.
 - 2 Draught Hood system, with grit arrester grid and water sprays.
 - 3 Container car, usually with dry coke quenching.
 - 4 Coke car with integrated hood and mobile deduster.
 - 5 Coke transfer machine with integral hood and remote stationary abatement (IHRA), preferably a fabric filter. For example, the “Minister Stein” system. (BREF PI.1)
- 32 The IHRA approach is BAT in the UK for new or rebuilt batteries, (i.e. from pad up).
- 33 On existing batteries, an acceptable interim solution is to use the Draught Hood system until then.
- 34 Where Draught Hoods are used, Operators should consider interlocking sprays with the ram to ensure sprays are functioning before pushing commences.
- ### Measurement and management of pushing emissions
- 35 Where an IHRA or Minister Stein system is used, good carbonisation is still important to minimise fume which may escape collection. For batteries without such a system, managing carbonisation conditions is critical.
- 36 Every coke push should be assessed for black (undercarbonised) areas and a (written) exception reporting system used to take action when performance is unacceptable.

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Indicative BAT requirements for coke making (Sheet 5 of 7)

37 A quick assessment of performance can be made by checking the above records and watching to see if the pushing emission plume carries off-site. Automated pushing emission monitoring is not currently possible but some UK sites are developing measurement of coke temperature at the guide as a carbonisation control tool. The BREF suggests a temperature probe on the coke ram can survey wall temperature profile. In the absence of an IHRA system, CCTV and video recording of the coke side should be used by management to provide a check. Systematic assessment of emissions should be undertaken using the BCRA Pushing Emission Factor (PEF) method. This is an important measure for trend analysis of carbonisation performance. (Note that PEF considers smoke and fume but not dust). Variation of battery statistical average temperatures outside agreed tolerances, sticker ovens, use of back-up charging cars (e.g. for wet coal) and breakdown of abatement plant should be notified to the Regulator on an agreed basis. (BREF EP.5)

Quenching operations

38 Wet quenching produces a white plume of condensed water vapour. Odour in this plume is not normally a pollution problem and steps should be taken to prevent the quench water becoming contaminated with untreated by-product plant liquids. Where necessary, top sprays should use clean water to limit the release of salts. Quench towers should be fitted with lamella stack baffles for grit arrestment. There are several suitable designs compatible with the types of quench towers in use. Some designs incorporate automatic backwash sprays to keep the grit arresters clear. The grit arresters need inspection at regular intervals with steps taken to clear any blockage or replace damaged sections promptly. Care should be taken in siting quench towers since under certain combinations of atmospheric and topographical conditions the plume can descend to ground level and may affect surrounding areas.

39 Collection pits under quench towers should be cleaned out periodically as sludges are produced.

Developments

40 Before building or rebuilding coke oven batteries to produce blast furnace coke, the Operator should consider alternative technologies, such as “non-recovery” coke ovens. These operate at negative pressure thereby reducing fugitive losses and all of the off-gas is burned on-site to provide heat and power. This process is an established technology in the USA. It is also necessary to show that alternative options, such as increased coal injection, are not the BPEO.

Collection and purification of gas and by-products

41 Emissions to air may occur in the following areas:

Gas cooling and scrubbing

42 BAT for new plant is gas-tight plant and existing plants should come close to this. Applicants should state how close they are to that standard and plans to reach it. A systematic approach to leak detection and repair should be used, eg drawing on the experience of the petroleum sector using Leak Detection and Repair (LDAR). (Details of the methodology used in refineries is provided in the Refineries BREF (4.23.6.1); assessment method as USEPA Method 21 and calculations in accordance with Report EPA/453-R-95-017).

43 Ammonia and hydrogen sulphide fumes are released from tar decanters, liquor sumps, storage tanks and spillage's. Emissions of benzene can occur from benzole storage tanks especially during transfer, filling and loading operations. Harmful emissions from these vessels should be minimised where possible, e.g. by fitting covers and abated vents, as appropriate. Vapour return lines should be used and vents should be connected to the COG collecting main, where appropriate and considered safe. Water scrubbers should be used on vents to atmosphere to reduce ammonia emissions. Pipe joints should be welded and pumps should be gas tight (e.g. integral), where possible. (BREF EP.10)

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44 Good design and maintenance should be used to minimise spillage and leakage from pump glands, pipe flanges and other connections. By-products plants are difficult to keep clean but spillages and leaks can lead to odour and ground contamination so good housekeeping is essential. Valves, vessels and machinery should be clearly labelled to minimise risk of accidental release.

Flaring and Bleeders

45 Flaring should be minimised.

46 Emergency venting through bleeders should be prevented by avoiding the need. Provided it is safe to do so, COG released from bleeders should be ignited as soon as practicable (typically, pilot flames are currently maintained at each bleeder exit for this purpose but spark plug igniters are BAT on new installations). Records should be kept of the time, date, duration, cause and actions arising from any bleeder use.

Ammonia incineration

47 This process utilises two-stage incineration to convert the ammonia vapour released in the stills to nitrogen and water vapour. Monitoring and adjustment of burner conditions are necessary to minimise the generation of oxides of nitrogen. Any sulphur compounds associated with the ammonia vapour will be converted to oxides of sulphur and emitted from the incinerator stack. These emissions should be minimised by the operation of a de-acidifier at the ammonia still, which largely separates the hydrogen sulphide to be re-cycled to the main gas stream. This is only effective if further downstream desulphurisation is employed.

Control of releases to water

Battery operations

48 Water used for coke quenching is re-cycled after removal of solid particles in a settling pond. Overflow from the system, if there is any, should be directed to a biological treatment plant or reed bed for treatment.

49 Surface water around the coke ovens and by-products plant should be collected and treated. It is important that good housekeeping practices are adopted to prevent spillage of materials, which would ultimately be washed into the drainage system.

Collection and purification of gas and by-products

50 Wastewater from the by-products plant should be collected and treated. The wastewater ("coal water") arise mainly as excess stripped liquor from the ammonia stills and condensate from the benzole plant and contain, organic (phenols and PAH) and inorganic nitrogen compounds (ammonia and cyanides).

51 Water treatment arrangements should include:

- Balance tanks upstream of the treatment plant to smooth out flows and concentrations of pollutants.
- Gravity separation of oils and tars. This may need to be supplemented by further pre-treatment using for example centrifugal separators or filtration, including vacuum filtration. (BREF EP.8)
- Keeping the concentration of ammonia in the stripper and still effluent low to benefit a biological water treatment process. This can be achieved through dosing with NaOH and increasing the number of trays in the stripper. (BREF EP.9)
- Minimisation of the presence of wash oils in the effluent streams as these can inhibit treatment.

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- 52 Wastewater treatment systems should usually be based on activated sludge systems, though reed beds may be acceptable if performance is demonstrated as comparable. Generally, aerobic treatment is sufficient. However, where discharge is made to sensitive water courses biological nitrification-denitrification, i.e. combined biological aerobic and anoxic treatments to reduce discharges of nitrogen compounds, should be considered. A final settlement stage is normally required, to meet suspended solids benchmarks or environmental quality standards. (BREF EP.11)
- 53 Water treatment sludges can be recycled to the coke ovens by thorough mixing with the coal feed, if sufficiently low in moisture content.
- Treatment/disposal of blowdown from COG desulphurisation using Wet Oxidation (REDOX) processes**
- 54 Options to treat the blowdown and partially recover process chemicals are:
- high temperature reduction of the fixed salts by gaseous and/or solid reducing agents to release hydrogen sulphide to be returned to the main gas stream and recover some chemicals which are recycled to the scrubber system
 - oxidation by air at elevated temperature and pressure, yielding sulphate. Certain chemicals may be recovered by ion exchange techniques and then returned to the scrubbing solution
- Control of releases to land**
- Battery operations and by-products plant**
- 55 The generation of solid wastes from battery operation should be minimal, and may include contaminated redundant equipment, refractory linings and cleaning debris.
- 56 The generation and use of wash oils needs to be controlled to avoid contamination of land and hence contamination of both surface and groundwaters.
- 57 Waste oil from interceptors, sweepings and sludge from treatment plants should be recovered and blended with the coal where possible.
- 58 In processes that employ a desulphuriser, some impure sulphur and scrubber liquor sludge effluent will be produced. Where the scrubbing process selected is the Stretford process, waste liquor containing vanadium catalyst and anthraquinone will be produced. If these streams cannot be re-cycled they will have to be landfilled as hazardous waste.

2.1.4 Blast furnace iron making and related activities

Table 2.3: Blast furnace iron making and related activities

Works	BF	Hearth diameter m (tap holes)	Work Vol. m ³	Top pressure	Top mods	Injection	Status at 03/2003	Capacity Kt/week	Last reline (date blown in)
Teesside	1	14.00 (4)	3,628	H	PW/T	Oil	W	62.5	10/00
Scunthorpe	QM	8.28 (1)	1,290	M	MA	Coal	W	21.5	4/93
	QB	8.33 (1)	1,315	L	MA	Coal	W	20.5	4/98
	QA	9.00 (2)	1,537	M	PW	Coal	W	24.8	3/91
	QV	9.00 (2)	1,537	M	PW	Coal	W	24.8	12/89
Port Talbot	4	10.80 (2)	2,134	H	PW	Coal/Oil	W	36.0	9/92
	5	10.80 (2)	2,134	H	PW	Coal/Oil	W	32.0	1/03

All operated by Corus UK Ltd.

Top pressure: L = 0.2 bar; M = 0.5-0.8 bar; H = > 1 bar.

Top modifications: PW = Paul Wurth Top; MA = Moveable throat armour; T = Top pressure recovery turbine.

Status: W = working.

All have cast house fume abatement.

2.1.4.1 Blast furnace iron making

Summary of activities

The function of the blast furnace is to reduce solid iron oxides to molten iron. Blast furnaces are the major source of molten pig iron ("hot metal") in the world and individual furnaces are capable of producing in excess of 10,000 t/day.

BREF Section 7

The blast furnace is a tall, shaft-type furnace, with a vertical stack over a crucible-shaped hearth (Figure 2-5). It is completely lined with refractories and extensively equipped with copper or cast iron inserts, which are cooled either by forced water circulation or by evaporative steam cooling. Near boiler-quality water is used for cooling and the closed circuit cooling systems are usually equipped with air-cooled heat exchangers. The outside of the hearth or well of the furnace may be cooled by cast iron coolers or external sprays and the underside of the hearth by forced-draught air or water cooling.

The iron-bearing feedstock materials and the coke are charged through a gas-tight, double valve system into the top of the furnace and pressurised air heated to 900-1350 °C ("hot blast") is blown in through water-cooled nozzles ("tuyeres") round the periphery of the furnace just above the hearth. Coal (pulverised or granulated), oil or natural gas, together with oxygen, may be injected with the hot blast to

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reduce the consumption of coke and to increase the output of the furnace. The hot blast blown into the furnace through the tuyeres is heated in regenerative refractory-filled “hot blast stoves”, which are fired with blast furnace gas (usually enriched to achieve high blast temperatures).

The furnace may be equipped for “high top pressure” operation of 1 to 2 bar, to further improve the efficiency and output. As the gases exit the top of the furnace, this pressure may be utilised to generate electricity via a back-pressure turbine (“expander”). The waste gas is cleaned in a dry cyclone-type dust catcher to remove coarse material and in a two-stage venturi scrubber, which regulates the furnace top pressure. A pressure relief system, often referred to as the “bleeder valves”, is used to limit the effects of excess pressure excursions due to occasional slippage of the burden inside the furnace.

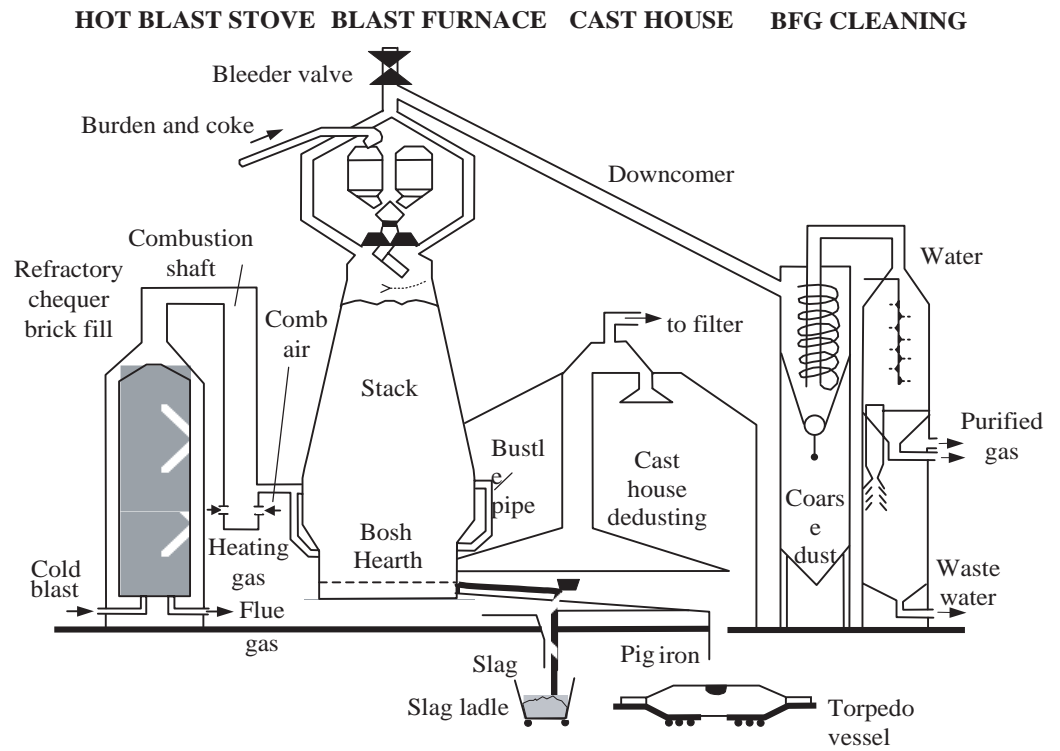
The iron-bearing materials (rubble ore, sinter and/or pellets), coke and perhaps some fluxes, are normally supplied by belt conveyor to the blast furnace bunkers. These raw materials are screened and weighed out of the bunkers in the required proportions and charged in a pre-planned order into the top of the blast furnace. Whilst transport of the burden to the top of more modern furnaces is usually by inclined belt conveyor, older furnaces may still employ a twin skip hoist system. The material is charged more or less continuously into the top of the furnace through the gas seal arrangement, which in many modern furnaces is pressurised (purged) with nitrogen.

Combustion of the coke in the furnace charge provides the heat necessary to melt the iron and slag and the gas produced (mainly carbon monoxide) reduces the iron oxides to metallic iron. The top gas leaving the blast furnace contains carbon monoxide, carbon dioxide, nitrogen and hydrogen and, after cleaning and cooling, the gas is used throughout the works as a fuel. Gas cleaning is usually a two-stage process, with the coarse grit being removed in a cyclone, followed by a wet scrubber, which removes the fine particulates, ammonia and cyanide. Most of the sulphur is retained in the slag.

The reduced molten iron and slag percolate through the unburned coke in the lower part of the furnace and accumulate in the furnace hearth, from where they are periodically tapped off via refractory-lined channels or “runners”. The hot metal is discharged into transfer ladles or “torpedo vessels” for transport to the steel plant, while the slag may be sent to slag cooling pits, pelletisers or a granulation plant.

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Figure 2.5: Blast furnace



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Plating of iron

“Plating out” of hot metal into open pits (also known as “ponding” or “puddling”) is carried out as a short-term measure if steel production cannot keep pace with iron supply and hot metal buffering capacity is full. Iron fume generation can be significant if splashing and oxidation are allowed to occur. The iron is poured in layers (say 50 mm thick) on top of already chilled iron. Since the beds are normally allowed to air cool, there are no process water releases, although there may be some run-off of rain water if the beds become completely cold. The iron is recovered by drop balling it into pieces and recycling to the steel plant.

Iron granulation

Granulation of molten iron can be used as an alternative process to ponding or pig casting. In the granulation process, molten iron is poured from a ladle at a strictly controlled rate into a high volume stream of fast-flowing water. The iron is immediately quenched and granulated and carried off in the water stream to a settling pond, from where it is removed by a mechanical grab. The process water is recirculated through a cooling tower. Fume generation during the process is minimised by the slow, controlled rate of pour necessary to carry out the operation in safety, although a substantial quantity of steam is released.

2.1.4.2 Releases

Air:

Releases

The raw gas leaving the blast furnace contains particulate matter (mainly iron oxides, heavy metals and carbon), carbon monoxide, carbon dioxide, hydrogen, zinc fume, sulphur compounds, ammonia, cyanide compounds, hydrocarbons and PAH. Raw gas may be released through the bleeders during process upset but normally the gas is scrubbed - removing particulate, zinc, ammonia, cyanides and some sulphur and trace hydrocarbons - before use.

BREF Section 7.2.2.1

Cleaned blast furnace gas can be used throughout the steel works as a source of energy. Since virtually all the blast furnace gas is captured and cleaned to a high standard (< 10 mg/m³ of particulate), there are no significant routine primary releases to air from the blast furnace. However, there can be small but significant leakage of gas from the furnace structure and episodic releases of gas and dust pollution from bleeder valves at the top of the furnace in the event of a gas surge or burden slip. Indirect emissions will occur when blast furnace gas is combusted in the stoves, boiler plant and other facilities.

A quantity of gas is vented during charging, but it is not normally practicable to abate this release with the current generation of UK blast furnaces. Proposals for any new or substantially changed plant should include the capture or minimising of these releases.

Secondary emissions to air during cast house operations are mainly particulate matter, where hot metal and slag are in contact with ambient oxygen. A small amount of SO₂ may also be emitted from the slag during cooling, whilst VOCs and PAH may be released from the runner systems where tar-based binders are still used.

The cooling of molten slag generates diffuse H₂S and SO₂ emissions, which can vary in quantity depending on the slag processing techniques used and the sulphur content of the coke used in the blast furnace.

The emissions from the hot blast stoves are mainly combustion off-gases. The SO₂ emitted is minimal. NO_x is minimised in the stoves by controlling oxygen levels; although this is for engineering rather than environmental reasons, as the quantities of NO_x are small.

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Water:

Large quantities of clean water are used to cool the furnace structure, tuyeres and other equipment. The water systems should be closed circuit, i.e. recirculating the water. Relatively small amounts of water are released from such circuits, except under exceptional circumstances, which occur extremely rarely, when the circuit may be drained for major reconstruction/repair, such as relining of the blast furnace or inspection/cleaning of water sumps.

Large volumes of water are also used for cleaning and cooling of the CO-rich furnace gas, which is used as a fuel. This recirculating water circuit becomes heavily contaminated with suspended solids and a variety of dissolved species, including alkaline salts, cyanide, zinc, lead and fluoride and, to a lesser extent, other compounds such as ammonia and phenol.

Water is released from the furnace gas cleaning system in the sludge underflow from clarifiers/thickeners and may also be discharged as a blow-down to control the level of dissolved solids in the cooling circuit.

Blowing down the furnace (i.e. draining metal, reducing or removing the coke burden and depressurising) can lead to a surge in cyanide content of the waste water.

Apart from discharges arising from the gas cleaning water system, other effluents may be created by demineralisation or water softening plants, which may be used to provide make-up to the clean closed water circuits.

Land:

The coarse dust from the dry “dust catcher” is normally recycled to the sinter plant. The finer sludge from the blast furnace gas cleaning system may contain significant levels of heavy metals and alkali metal chlorides, which may preclude recycling.

BREF Section 7.2.2.2 - 4

Where this sludge has to be landfilled, consideration should be given to the potential risk of groundwater pollution. In many plants abroad, the sludge is dewatered to produce a cake with about 20% moisture content, which is then recycled or sent to landfill.

Wet gas cleaning has the advantage of removing soluble trace gases (e.g. ammonia) but requires water treatment, and produces a sludge requiring further treatment and disposal. Cyclonic pre-treatment helps by removing much of the particulate. Any developments in dry cleaning should be monitored.

Waste:

As in all the other parts of a steel works which handle molten metal, waste refractories are generated when ladles, runners and process equipment are relined. On extremely rare occasions at very prolonged intervals, blast furnaces and stoves are completely relined with refractory. Such major events are normally planned years in advance.

Energy:

Blast furnace gas typically has a calorific value of about 3 MJ/m³ and is used on-site.

Accidents:

Failure of, or leakage from, blast furnace system components may release BF gas. BF gas storage and distribution systems typically have pressure relief systems situated at low level. Releases of BF gas can expose people on or off site to elevated levels of carbon monoxide.

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Noise:

Apart from the blowing plant, which forms part of the works power station, the normal main sources of noise associated with the blast furnace are the regular pressurisation and depressurisation of the hot blast stoves and the fans serving the cast house ventilation and cooling water systems.

During abnormal conditions caused by gas surges or slippage of the burden, temporary high noise levels can arise due to brief intermittent blow-off of blast furnace gas through the “bleeder” valves at the top of the furnace. Sound levels of 122 dB(A) can arise. A system of assessing the causes of such releases and minimising risk of occurrence is required.

See BREF Section 7

Indicative BAT requirements for blast furnace iron making and related activities (Sheet 1 of 4)	
Control of primary releases to air	
1	While recognising that much of the sulphur released is retained in slag, Operators should make efforts to minimise the level of sulphur input to the blast furnace in order to reduce emissions downstream in the process. Approximately 90% of the sulphur normally comes from the coke, so Operators use low sulphur coking coals.
2	The primary gas is normally cleaned by passing it through an expansion vessel (cyclone-type dust catcher) and a multi-stage wet scrubbing system (venturi or cone scrubber), which removes iron-rich dust containing alkali metal chlorides, heavy metals and PAH. BAT is concerned with optimising control, maximising the use of the iron-rich sludge, and minimising aqueous releases. The water requirement is approximately 0.3-4.0 l/m ³ . This corresponds to a gross water consumption of 0.4-8 m ³ /t hot metal, but most of this water can be recycled after treatment. (BREF EP.1)
3	Practices should exist to prevent or minimise the release of the CO-rich blast furnace gas to atmosphere. CO emissions from hot stoves with an internal combustion chamber can be reduced by inserting steel sheets into the refractory wall during relining.
4	A systematic approach should be used to ensure the furnace parameters are controlled to minimise the risk and extent of gas surges (including blow through of raceway from the tuyeres) or burden slippage. These can result in significant emissions of furnace gas to atmosphere through bleeder valves, sometimes with associated high frequency noise. Such releases should be recorded, the causes investigated and steps taken to minimise the risk of recurrence.
5	Applicants should justify the sequence in which vent and bleeder valves open, with a view opening the cleanest first (stove snort valve and then gas cleaning plant bleeder before furnace top bleeders), if safe and practical to do so.
6	Gas generated in the blast furnace that cannot be utilised as a fuel should be flared via a suitably designed flare stack. This should provide smokeless combustion at all times and the satisfactory dispersion of combustion products and heat. Flaring of gas from the blast furnace system will normally only be carried out when the production of gas is greater than can be used and insufficient gas storage capacity is available. BFG should not be vented, except in emergency.
Cast house	
7	In the cast house, large quantities of dust, fume and sulphurous gases are generated. These are evolved during tapping of the furnace, the transfer of hot metal and slag through the runners, and where the former falls into the transfer or mixer ladle. Suppression techniques or local extraction systems at the tapping and ladle filling locations should effectively capture these emissions.

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Indicative BAT requirements for blast furnace iron making and related activities (Sheet 2 of 4)

- 8 Effective cast house fume collection and abatement is essential. A bag filter or electrostatic precipitator should be used to remove fume from the extracted air, to give no visible fume at filter/precipitator exit. BAT for new installations is a bag filter. (BREF EP 2 & 3)
- 9 Applicants should describe how their hardware and control philosophy should avoid upset and start-up/shutdown conditions that produce more fume than the system can abate effectively. Reference should be made to techniques used across the whole company, justifying which are employed for this particular application. Some examples of the techniques expected to be referenced include:
- drill alignment brace to ensure repeatability of drill hole and eliminate lateral movement of drill
 - brace on the clay slew gun to ensure correct alignment; plywood caps on the clay/hearth frontier to ensure a good and consistent fill of the taphole
 - software control programs to alert operators to deviations from “idealised” conditions (which could indicate blow through or burden slippage potential)
 - an “expert” system to try and match casting rate to loading rate to maintain steady liquid level.
- 10 A programme of preventative maintenance should be provided with the application, including filter bag replacement as appropriate.
- 11 The operation of fume extraction systems may be optimised under computer control, to open and close dampers and to regulate variable-speed extraction fans to minimise energy consumption. Such control systems may be justifiable on both environmental and economic grounds.
- 12 Tar-free runner linings should be used to minimise PAH and VOCs.
- 13 Where slag granulation is undertaken, the use of fume condensation should be assessed and implemented if appropriate. (BREF PI.5)
- Stock house**
- 14 Within the stock house, all the screens and conveyor systems should be enclosed; and connected to a dust extraction system where necessary to avoid dust release. Dust suppression water sprays may also be employed. Since the different screens do not operate simultaneously, the installation of shut-off dampers in the extraction ducting to control the volume of air being drawn through the system can often be justified by the energy savings. Either an EP or a bag filter can achieve the release levels in Section 3.3 for the cast house and stock house. However, fabric filters will achieve lower emission levels and would therefore normally be required for both new installations and retrofitting to existing plant.
- Direct injection of reducing agents**
- 15 Applicants should give the status of any arrangements for direct injection of reducing agents such as coal and oil, specifying injection rate and residual coke rate (as kg/t hot iron). A reduction in coke rate has significant environmental advantages. Best practice is about 210 kg coal/t hot metal, corresponding to 270-300 kg coke/t hot metal, and higher rates may be possible with oxygen enriched air blast. Applicants should justify what they consider the maximum coal injection rate for each size/configuration of furnace they operate and submit an improvement programme to achieve it, if there is a shortfall. (BREF Emerging Technique Section 7.5)
- 16 Note: Use of waste mineral oil will introduce requirements of the Waste Oil Directive (WOD). Vegetable oil is not covered by the WOD.

Introduction		Techniques for pollution control			Emissions			Impact			
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Indicative BAT requirements for blast furnace iron making and related activities (Sheet 3 of 4)

Plating of iron

- 17 When plating iron the following measures should be adopted: (i) carefully controlling the metal pour to minimise splashing; (ii) pouring into a shielded tundish; and (iii) nitrogen blanketing. Records should be kept of the reason why each ladle had to be plated.

Kish formation

- 18 When hot iron is poured the drop in temperature can cause the precipitation and emission of iron graphite (kish). This problem can occur when plating or in the steel making shop when charging mixers or BOS vessels. The storage and transfers of hot metal in ladles and torpedoes should be managed to minimising heat loss. Lids or covers should be introduced for ladles and torpedoes where practicable. Avoiding excessive hot metal temperatures can help to minimise the amount of kish generated.

Stand-by blast furnaces

- 19 Operation of a stand-by blast furnace, which is used only once every few years for limited periods of typically around 3 months, should not be authorised unless a satisfactory plan of improvements is in place to ensure that there is no greater effect on the local environment during its operation or from the associated slag activities, than during operation of the main blast furnace(s). An assessment should be made of the risk of plant failure.

Control of releases to water

- 20 Cooling water should be recirculated and the make-up rate monitored to indicate if there may be tube leakage (which may result in deterioration of structure and increased CO leakage).
- 21 The recirculating water used for cleaning and cooling of the blast furnace gas becomes contaminated with suspended solids and a range of dissolved species, including alkaline salts, cyanide, zinc, lead and fluoride and, to a lesser extent, other compounds such as ammonia and phenol.
- 22 The suspended solids in the recirculating water are removed by settlement in devices such as clarifiers, often with the aid of flocculation. The sludge removed from the clarification process is typically either settled in a lagoon or thickened and dewatered by rotary vacuum filters or other types of mechanical filter. The zinc, lead and fluoride content of the waste water should be controlled to acceptable levels by conventional flocculation and precipitation techniques, whilst compounds such as cyanides, phenol and ammonia should be controlled by oxidation. Depending on the operational conditions of the furnace, cyanide treatment may be necessary during blowdown, e.g. using ferrous sulphate.(BREF EP.5)
- 23 The manner in which the final discharges of waste water from the “dirty” recirculating water system of the blast furnace(s) are treated and re-used or disposed of will be strongly influenced by the facilities available to discharge effluent and the economics of alternative methods of utilising low-grade water.
- 24 Surface water run-off should have solids deposition and oil separation arrangements. Pollution prevention systems should be described in the Application.

Control of releases to land

- 25 Blast furnace slag is normally re-used for various purposes, including on-site road make-up and sale as a road stone or to the cement industry. (Section 2.3.10 deals with slag utilisation in greater detail.)

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Indicative BAT requirements for blast furnace iron making and related activities (Sheet 4 of 4)

26 Dry grit and dust captured in the initial stage of gas cleaning will normally be sufficiently free of tramp elements such as zinc and lead to be recycled to the sinter plant. Wet sludge from the venturi scrubber system is usually disposed of to landfill because of the presence of zinc and lead. However, classification of blast furnace sludge using a hydroclone can give a zinc-rich overflow and zinc-lean underflow. The later can be recycled to the sinter plant. Proposals to introduce this technique, or an appropriate justification why not, should be provided.

Waste

27 Waste refractory is normally disposed of by landfilling. Opportunities to utilise waste refractory materials should be considered by the Operator.

Venting

28 If the capacity of BF gas use, storage and flaring systems has been reached, production should be reduced to achieve a balance. Venting the surplus gas is unacceptable except as an emergency measure for health and safety reasons.

2.1.5 Hot metal mixing

BREF Section 8.1.1

Process:

The hot metal from the blast furnace can be temporarily stored in large insulated torpedo or transfer ladles, which can hold sufficient hot metal for a number of charges to the BOS converters.

Air:

The main releases are fume, generated during pouring and any combustion off-gases from the mixer furnaces. The pouring operations produce large volumes of iron oxide fume and kish.

See BREF Section 8.1.1

Indicative BAT requirements for hot metal mixing

Control of releases to air

- 1 The fume and kish given off during the transfer of hot metal into the hot metal mixers and particularly when pouring from the mixers and torpedo ladles into the BOS charging ladles should be captured and filtered. When pouring the metal, fume generation can be reduced by minimising the pouring distance and pouring rate. As mentioned previously, trials have taken place using either nitrogen or CO₂ as a fume suppressant during pouring and other hot metal transfer operations. Such techniques can reduce the generation of fume (iron oxide), but does not prevent the formation of kish.
- 2 Releases of combustion gases can be minimised through selection and optimisation of appropriate burners and combustion control systems.

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2.1.6 Iron desulphurisation

BREF Section 8.1.2

Process:

The molten iron from the blast furnace contains undesirable amounts of carbon, manganese, silicon, sulphur, phosphorus and minor quantities of other elements, which are reduced or removed in the steel making process. However, sulphur in hot metal is more effectively removed in a separate process carried out in the ladle prior to transfer to the steel making vessel. An early method of desulphurisation involved pouring the molten metal into a transfer ladle containing a quantity of soda ash or a mixture of soda ash, coke and magnesium. It is now common practice to deep-inject the reactants, comprising salt-covered magnesium granules or calcium carbide, into the ladle using a refractory lance and inert carrier gas. The resulting high-sulphur slag is skimmed off the surface of the metal with a mechanical rake or “rabble”.

Air:

The main releases during iron desulphurisation operations are of fume and kish.

Land:

Slag is produced during the desulphurisation process.

Waste:

The slag can be difficult to utilise due to poor mechanical properties. It can have a high content of sulphur and iron. Consequently, this slag is not suitable for most slag recycling uses and is usually either landfilled on the site or used for the construction of on-site noise barriers and other low-specification projects.

See BREF Section 8.3

Indicative BAT requirements for iron desulphurisation

Control of releases to air

- 1 The gas and fume emissions from the desulphurisation process, the skimming station and the decanting station should all be collected effectively using an enclosure and dedusted in either a fabric filter or EP. The recovered dust is not usually suitable for recycling. (BREF EP.2)

Control of releases to water

- 2 Any surface water run-off should have solids deposition and oil separation arrangements. Pollution prevention systems should be described in the Application.

Control of releases to land

- 3 Desulphurisation slag is difficult to use or recycle and kish emissions can be a significant site issue. Operators should minimise slag production, with improvement programme as appropriate. The application should state measures taken to minimise iron loss into slag, as this is significant factor in kish emissions from slag handling.

Emerging techniques

- 4 Several “foaming” techniques are already available for pre-treatment of iron. The benefit of foaming techniques is that particulate matter can be absorbed into the foam. The displacement of air by inert gas above the molten metal during pre-treatment reduces the production of metal oxides and fume. Industrial-scale tests have used nitrogen and CO₂ to shroud the transfer of molten metal between vessels, though potentially the use of nitrogen might increase the emissions of NO_x.

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2.1.7 Basic oxygen steel making

Table 2.4: Basic oxygen steel making processes

Works (date built/modified)	BOS vessels of size (active)	Liquid steel capacity Mt/a Iron or Concast constrained	Blast furnace support	Facilities for iron desulphurisation	Post vessel treatments
Teesside (1971/78)	3 of 261 t (2)	3.7 Iron	1	Deep coinjection with CaC ₂ & Mg (transfer ladle)	SL ladle injection RH degassing Argon stirring Ladle arc furnace Tank degasser
Scunthorpe (1973)	3 of 300 t (2)	4.0 Iron	3	Soda ash Inject-mag	RH degassing Ca/Si injection
		4.5 Concast	4		Pb facilities 2 Ladle arc furnaces Steel desulph.
Port Talbot (1973)	2 of 340 t (1)	3.5 Iron	Nos 4 & 5	CaC ₂ /Mg/Na ₂ CO ₃ Injection (transfer ladle) 20 kt/w of iron	CASOB DH degassing RH-KTB

All operated by Corus UK Ltd. All have secondary fume collection and abatement.

BREF Section 8

Process:

The basic oxygen converter consists of a large open topped steel vessel, which is lined with basic refractories, and is mounted in a trunnion ring assembly. The vessel is capable of rotation through 360°. Above the vessel is a large water-cooled duct connected to a gas cleaning plant, which evacuates, cools and cleans the hot waste gases from the vessel before discharge. The BOS vessel is charged with up to 30% steel scrap, with the balance as hot metal.

There are two basic technologies employed. In the original concept of the process (the LD converter) oxygen was blown at supersonic velocity through a water-cooled lance on to the surface of the molten iron, burning the carbon and oxidising the metalloids into the slag. In a later development of the process (known generically as Q-BOP), oxygen and other gases were injected through a tuyere in the bottom of the vessel, giving various metallurgical advantages. In due course the two technologies were combined and currently there are a number of combination processes, where the possible injectants include nitrogen, argon, flux and fuel gases.

At the start of the steel making cycle, the converter is tilted to the charging side at an angle of approximately 45° and charged with pre-weighed scrap from a scrap "box". Up to 30% of the charge weight can be scrap, depending on the quality of iron being used - 20% is typical. The molten hot metal is then poured on to the cold scrap and the vessel returned to the vertical position. Flux-forming material, such as lime, is fed into the vessel from a chute located above the converter. At some plants, special additions are made, e.g. sulphur to produce free cutting steels (this produces some SO₂); another is tellurium, with a garlic odour. A water-cooled oxygen lance is lowered to a fixed position above the liquid metal charge and high-pressure oxygen is blown onto the surface at supersonic speed. Almost all of the energy released in the blowing process originates from the hot metal. 40% is in the form of thermal energy and 60% is in the form of chemical energy contained in the carbon and other

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elements in the iron. During the blowing process, some of these elements react with the oxygen to release heat. At the same time, carbon burns to form carbon monoxide and carbon dioxide. Some of the iron is oxidised and is entrained in the flue gas as dust particles. If control of the exotherm is lost, “slopping” will occur where hot metal overflows from the converter. This is a particular risk using high phosphorus ores. When the steel composition and temperature are correct, the vessel is tilted to the tapping side of the shop and the steel tapped into the casting ladle. After tapping the steel, the slag is drained off by pouring from the mouth of the vessel into a slag pot, which is used to transfer the slag to cooling pits. After solidification, the slag is removed for crushing, recovery of metallics and disposal or use as a secondary material.

Air:

The main releases to air from the BOS steel making process are particulate matter (mainly metal oxides) and CO, with relatively small amounts of sulphur oxides and nitrogen oxides. Slopping can cause large releases of molten metal and fume, overwhelming the secondary fume collection system. Fume can also be released from the building, when additives are being fed to the converter. Additionally, very small amounts of PCDD/F and PAH are emitted. Significant quantities of NO_x can be released at the ladle preheating and heating facilities.

Water:

BREF Section 8.2.2.3

Clean water is used in recirculating “indirect” cooling systems serving various items of equipment such as the oxygen lance, primary fume extraction hood and associated hot gas ducting. Water can be discharged as blow-down if parts of the circuit are evaporatively cooled, but since most plants use closed circuit fin/fan cooling, releases of wastewater are normally negligible from such circuits. More recently, some plants also employ evaporative air mist cooling of the cone of the converter vessel. This should not create releases of wastewater if the system is operating correctly. The recirculating “direct” contact water used to clean and cool the primary fume extracted from the converters becomes heavily contaminated with suspended solids and dissolved solids, which include alkaline salts, lead and zinc compounds, and fluoride. The concentration of dissolved solids in the gas cleaning water can vary widely, depending to a large extent on the operation of the furnace and the amount of water discharged as blow-down from the recirculating system. Demineralisation or water softening plants are often used to treat the make up water to the indirect cooling systems. Such treatment facilities, which may be centralised or serve individual process plants, give rise to a variety of waste water qualities, including acidic, alkaline and saline effluents.

Land:

BREF Section 8.2.2.2

The main releases to land are sludge from primary fume cleaning systems, dry dust from secondary fume cleaning and slag. Waste refractory is generated when ladles and converters are relined.

Waste:

Scrap and iron oxide briquettes can be recycled to the BOS converters as coolant material.

Accidents:

Feeding any closed container will cause an explosive release.

Contact between molten metal and water will cause a steam explosion.

See BREF Section 8.2.2.1

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Indicative BAT requirements for basic oxygen steel making (Sheet 1 of 3)

Control of releases to air: primary fume emissions

- 5 The blowing operations in the converter create an off-gas that is rich in CO (around 70%). This potential source of energy should be captured during the parts of the blowing cycle when the composition of the off-gas is suitable and utilised (unless covered by a CCL agreement). Applicants without collection and utilisation systems should review utilisation options in the application. (BREF PI.3)
- 6 In older plants, it is common to combust the off-gas with air at the mouth of the converter vessel and, in some instances, recover heat in the form of steam in the fume ducting system. When unburned off-gas must be released to atmosphere, it should be flared to combust the carbon monoxide and the design of the flare stack should ensure clean combustion at all times.
- 7 Effective control of the blow is essential if the primary gas cleaning system is to perform effectively. Otherwise unacceptable primary emissions will occur. Effective control requires:
 - adequate training and supervision of operators;
 - on-line sampling and steel analysis;
 - dynamic modelling of the blow;
 - adequate control of the blow so that the primary collection hood position and scrubber pressure drop are independently positioned for optimum gas collection and cleaning efficiency;
 - adequate pressure tappings (with double redundancy and purges);
 - state of the art audiometers;
 - attention to consistency of scrap quality to help blow modelling and avoid excessive requirement for iron ore addition which will overload primary gas cleaning;
 - arrangements to adding additives progressively rather than in one batch; and
 - a system for consistently grading slopping, reporting serious occurrences and feeding back improvements. (BREF PI.3 & EP.1)
- 8 Applicants should compare their proposals with the BREF reference methods for primary dedusting.
- 9 A system of monitoring, recording and managing both excessive primary and fugitive releases from the building is required.

Control of release to air: secondary releases

- 10 Whilst the majority of the primary fume is extracted directly from the BOS vessel, some fume may escape through the lance hole or from the annular gap between the fume hood and mouth of the converter. The control of the fume escaping from such sources requires, as an essential precursor, effective control of the blowing cycle to minimise the release but the use of secondary collection and control techniques are also necessary. This should ensure the amount of fugitive fume escaping the building is insignificant. (BREF EP.3)
- 11 Secondary releases of fume to the building through the lance hole of the fume duct can be reduced by blocking the hole with a movable "mill stone" or shielding the hole with inert gas or steam.

Introduction		Techniques for pollution control			Emissions			Impact			
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Indicative BAT requirements for basic oxygen steel making (Sheet 2 of 3)

- 12 Secondary releases of fume emitted during charging and tapping processes, and escaping from the primary fume extraction system, will occur. This needs to be captured and abated. The design of these systems, which will be retrofits on existing plant, will depend on local conditions. Local hoods, or an enclosure (“doghouse”) should be used, with any hood system as close to the converter as possible. The secondary fume collected is extracted to a bag filter or EP plant. However, charging is carried out by pouring hot metal from a ladle suspended on an overhead crane, so that local extraction hoods rarely manage to capture all the fume. Because of this, roof extraction from the building to a bag filter plant is normally required for both new and existing installations. The roof extraction system also captures various other fugitive releases, including those escaping from the local extraction hoods at the hot metal pouring stations. However, it is not practicable to rely on roof extraction alone to capture such releases. Good primary and secondary fume collection at the converter mouth is essential.
 - 13 Until a continuous particulate emission monitoring device is found which is suitable for the BOS primary flare stack, emissions from each blow should be assessed and recorded on an exception basis, if they exceed some predefined level. Similarly, if fugitive emissions from the building are significant these should be monitored with CCTV and noted on an exception basis. Normally, control of blows and fume collection should be sufficient to ensure fume releases from the building are insignificant.
 - 14 The bunkers that hold the flux additions are located in the roof space. The small releases from such sources should be fed into the roof extraction system.
 - 15 Either a bag filter or an EP should be able to meet the benchmark release levels suggested in Section 3.3 for secondary fume collection and abatement. Whilst the former abatement technique will result in the lowest particulate releases, the latter might enable more selective recycling of the dust. (BREF EP.3)
 - 16 Transfer of hot metal from the torpedo ladle to charging ladles should take place in an enclosure with fume extraction and collection in a bag filter or EP, or use an effective system of CO₂ blanketing.
- Control of releases to water**
- 17 The main releases to water arise from the recirculating water system of the primary fume cleaning and cooling circuit.
 - 18 Where wet fume abatement techniques are employed, the resulting process water is treated to remove the suspended solids and cool the water, prior to recirculation. Particulate removal typically involves two stages of separation: primary settlement to remove coarse particles, followed by settlement of finer particles in equipment such as clarifiers or settlement tanks. Flocculation additives are usually employed to improve sedimentation. After discharge from the clarifier, settled sludge may be subject to further treatment in a thickener, followed by dewatering in such equipment as rotary vacuum filters, filter presses, tube presses or centrifuges. In cases where the clarifier underflow is discharged to settlement lagoons, the lagoons are periodically excavated and the sludge allowed to drain prior to disposal. Where the concentration of tramp elements such as zinc and lead are sufficiently low, this material may be recycled to the iron making process route. Otherwise, the material is disposed of to landfill. Recovery of tramp elements from the sludge is not usually economic. Throughout the world there has been increased effort to recycle the dust recovered from BOS gas cleaning systems and various techniques have been developed to recycle these materials to the sinter plant, blast furnace or BOS plant. (BREF EP.5)

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Indicative BAT requirements for basic oxygen steel making (Sheet 3 of 3)

- 19 The waste water discharged from the recirculating water circuit of the gas cleaning system should be re-used in other parts of the steel works for low-grade duties such as quenching or, as a last resort, disposed of as an effluent. The effluent treatment and disposal arrangements are normally site-specific but should meet the principles of PPC. The capacity and costs of final effluent treatment will be determined by the need not to deteriorate receiving waters and meet the various legislative requirements, e.g. of the Dangerous Substances Directive. Evidence is required to demonstrate an effective water management regime within the steel works, including a structured approach to minimising the consumption of water and volume of effluent discharged. Dilution is an unacceptable form of control.
- Control of releases to land**
- 20 Slag arising from BOS operations is crushed to recover the metallic content and the residual slag material is utilised where economic outlets are available or stockpiled at the steel works site. (See Section 2.12 for further details.) There is potential to recycle the sludge from the gas cleaning plant to recover the ferrous metal and recycle this material to either the blast furnace or sinter plant. However, the presence of zinc and other tramp elements can cause difficulties with the operation of the BF or affect the chemistry of the hot metal by altering the sinter chemistry. Steps can be taken to increase recycling by control of scrap quality charged to the BOS plant. Applicants should provide proposals to maximise recycling.(BREF PI.2)
- 21 Recycling can also be facilitated by separation of the coarse and fine particulate recovered from the primary fume cleaning system. The coarse grit is more suitable for recycling, as it contains less of the volatile tramp components. The application should include proposals to recycle this material.
- 22 Waste refractory is normally disposed of by landfilling. However, the amount of waste refractory previously generated within BOS plants has been reduced by modern refractory gunning techniques, improved refractories, air mist cooling of the converter cone and operational practices such as “slag washing” and “slag splashing” to protect the converter linings.
- 23 Dust from the BOS plant and other fine by-product materials containing high levels of iron should be recycled to the sinter plant or pressed in a “hot” or “cold” briquetting machine to produce briquettes, which can be charged back to the BOS furnace in place of scrap as a coolant. The Waste Oxide Briquetting process is an example. (BREF EP.4)

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2.1.8 Electric arc steel making

Table 2.5: Electric arc steel making plants

Operator	Built/rebuilt	Capacity per heat (t)	Status at 07/2003	Rating of transformer (MVA)	Nominal annual capacity (t)	Scrap pre-heating system	Dog-house	Principal market sectors
Celsa, Tremorfa	1993	160	W	100	900,000	No	No	Reinforcement steels
Thamesteel, Sheerness	1992	100	W	82	600,000	Yes	Yes	Engineering steels
Alphasteel, Newport	1977/84	120	W	55	450,000	No	No	
Outokumpu, Sheffield	1977	130	W	90	540,000	No	No	Stainless steels
Corus UK Ltd, Rotherham ¹	1984	165	W	120	1,000,000	No	No	Engineering steels
	1993	165	W	90		No	No	
Corus UK Ltd, Stocksbridge ²	1967/93	150	W	90	400,000	No	No	
Ervin Amasteel, Bilston	1962	7	W	3.1	15,000	No	No	Metal abrasives for shotblasting
	1978	8.5	W	5.6	30,000	No	No	
GKN Sheepbridge	1971	10	Standby	10	2,500	No	No	Automotive cylinder liners
Sheffield Forgemasters, Sheffield	1960/1	90	W	35/42	130,000	No	No	Heavy and other
Weardale Steel	1965	50 ⁴	W	22	2,000	No	No	Marine & general heavy engineering
London and Scandinavian, Rotherham		10	NO			No	No	
William Cook, Burton	1957	10	W	4	2,700	No	No ³	Offshore oil and gas, power generation, civil

Status: W - Working NO: Not Operating

Notes

¹ A second furnace was operational 06/2003.

² Due to close in August 2005.

³ Extraction is via an external hood.

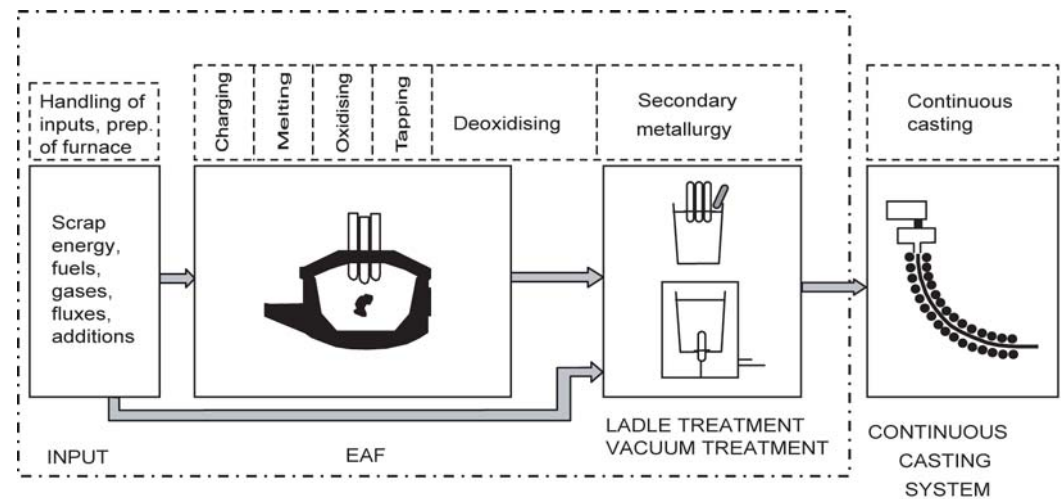
⁴ Plus two furnaces of 4t capacity.

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Only furnaces of 7t and larger are covered by this guidance. The table above summarises details for furnaces available when going to press. All furnaces fully detailed above are AC powered and have 4th hole primary fume collection, unless stated otherwise.

Thamesteel, Sheerness has a shaft furnace and uses a Carbofer process to inject a mixture of EAF dust, oily mill scale and carbon into the slag layer. An average 1.8t of recycled fines are injected per heat and 85% of heats contain recycled fines.

Figure 2.6: EAF steel making



2.1.8.1 Electric arc furnace process

Summary of the activities

Melting of ferrous material which have low or zero iron oxide content, such as steel scrap, is usually performed in Electric Arc Furnaces (EAFs), which play an important role in the recycling of ferrous materials recovered by the scrap metal industry. A schematic diagram of an EAF steel making process is shown in Figure 2-6. It should be noted that equipment design, energy consumption and emissions are affected by the type of steel produced.

BREF Section 9

The EAF consists of a steel refractory lined hearth with the upper shell consisting of water cooled panels and water cooled roof, which can be tilted to pour the molten steel through the furnace tap hole. The electrode(s) for input of electric power pass through the roof of the furnace, which can be slewed aside for charging the scrap feedstock. The roof also contains a “fourth hole” through which the gaseous by-products of the steel making reactions are discharged from the furnace to the fume cleaning plant. EAF have capacities ranging from a few tonnes to 200 t or more. Most of the existing EAF are powered by alternating current (AC furnaces) and have 3 electrodes, but direct current furnaces (DC furnaces) are becoming more common. The latter furnaces have a single electrode in the roof and a second electrode embedded in the hearth. DC furnaces tend to be used where the capacity of the electrical supplies systems is marginal for using conventional AC furnaces. Generally, DC arc furnaces produce significantly less electrical “flicker” and are considerably quieter than the equivalent AC EAF.

In the UK, the main feedstock for the EAF is manufacturing and post-consumer ferrous scrap, supplied to nationally agreed specifications by merchants in the waste management sector, supplemented by internal recirculating scrap arising within the steel works. It should be noted that this specification does not quantify the amount of contamination which may be present in scrap.

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Charging

The scrap is loaded into baskets, together with lime (sometimes dolomite), which is used as a flux for slag formation. Lump coal or coke is also charged at some plants to control the steel making slag through chemical reaction. In a conventional furnace, the electrodes are raised up through the furnace roof, which is then swung away from the furnace body to allow the scrap to be charged. Typically, about 60% of the scrap is charged with the first scrap basket. The roof is then closed and the electrodes lowered to within 20-30 mm above the scrap before striking an arc. After the initial charge has melted, the charging process is repeated by adding the remainder of the scrap using one or more further baskets. Most modern furnaces operate with a minimum of basket charges to reduce the dead time when melting and hence reduce the “tap to tap” time. Further, removing the furnace roof results in lost energy – which can amount to 10 – 20 KWth/tonne of liquid steel. Continuous charging operations can eliminate the charge cycle.

Melting and refining

Modern furnace designs are focused on maximising the melting capacity of the EAF using both electrical and chemical energy.

During the initial period of melting, the maximum electrical power is not applied in order to minimise damage to the furnace walls and roof from radiation, whilst allowing the electrodes to bore into the solid scrap. Once the surrounding scrap has shielded the arcs, the power can be increased to finish the melting. Oxy-fuel burners are often positioned in the sidewalls or on the slag door to melt scrap in the cold zones of the furnace and to even out melting. The auxiliary fuel is normally natural gas, although oil and coal can also be used. Oxygen, fuel gas or air may also be supplied to the liquid steel through tuyere nozzles located in the furnace hearth.

Oxygen is injected into the molten bath through a lance for decarburisation of the melt and removal of other unwanted elements such as phosphorus, silicon and sulphur and to achieve “post combustion” of carbon monoxide. This results in a marked increase in the generation of gas and fume, which comprise CO and CO₂ gases, extremely fine iron oxide particulate and other oxidation products.

Oxygen lancing also results in oxidation of the iron in the charge, leading to an increase in the bath temperature due to the exothermic oxidation reactions. The iron oxide reports to the slag and may be recovered by injection of carbon into the slag to reduce it back to metallic iron. Although the reduction reactions are endothermic, the generation of CO and CO₂ creates a foaming slag, which covers the electrode tips and increases the thermal efficiency of the furnace by stabilising the arcs and reducing radiation losses. It also helps to muffle noise.

Argon or other inert gases may be injected into the melt, usually through tuyeres and porous plugs, to provide bath agitation and temperature balancing. The slag-metal equilibrium can also be improved by this technique.

Steel and slag tapping

Slag is removed at the end of the heat, prior to tapping, and may also need to be removed during refining. This involves raising the electrodes and tilting the furnace backwards towards the slagging door, to allow the slag to run off or be raked into a slag pot or tipped on to the ground below the furnace. The resulting dust and fume generation can be partly suppressed by water sprays, providing the appropriate safety precautions are observed. To tap the furnace, the electrodes are raised; allowing the furnace to be tilted and the tap hole is opened to allow the discharge of molten steel into the ladle.

A technique known as “Hot heel” tapping is frequently used, which involves leaving up to 20% of the steel with some slag in the hearth, in an attempt to produce a slag free tap and speed up the tap to tap cycle time. Eccentric bottom tapping allows molten metal to be tapped from the bottom of the furnace free from slag inclusion. However, it is still necessary to remove slag from the furnace prior to tapping.

Introduction		Techniques for pollution control			Emissions			Impact			
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In plants without secondary steel making facilities, alloying and other additions are often made to the steel ladle before or, more commonly, during tapping the molten steel from the furnace. Such additions can noticeably increase the fume produced during tapping.

Scrap preheating

Scrap preheating can be used to reduce energy consumption and tap to tap time by utilising part of the sensible heat in the furnace off gas.

The “Shaft Furnace” and “Consteel” process are two technologies that incorporate scrap preheating, both have constraints which depend on the range of steels being made. The Shaft Furnace is proven technology.

The Shaft Furnace allows part of the scrap to be preheated by charging it through a vertical shaft that is integral with the furnace roof. The scrap is preheated by the process exhaust gas, which reduces the electrical power input during melting by up to 25% and increases productivity of the furnace. In the conventional shaft furnace, the initial basket of scrap is charged directly into the furnace shell, which can be moved from its normal position under the fixed roof to permit charging. The furnace is repositioned quickly under the roof and a short period of melting takes place using electrical arc power and the oxy-fuel side wall burners. The remainder of the scrap is then charged into the shaft, which is closed prior to recommencement of melting. During melting, the height of the scrap in the shaft falls as the scrap enters the molten bath. A further development is the “Finger Shaft Furnace”, which allows the scrap to be held in the shaft during refining, thus increasing the degree of preheating and recovery of energy from the exhaust gas.

A further variation is the double shaft furnace, which consists of two furnace shells, serviced by a single set of electrode arms.

Furnace off-gases passing up the shaft and preheating the scrap can lose up to 25% of the dust load due to contact with the scrap feedstock. Extraction of the off-gases is from one side of the top of the shaft and the gases may be passed to a combustion chamber to burn off any combustible substances. In such cases, the direct energy benefit of using a shaft furnace is lost, though energy is still saved through reduced tap to tap times.

The Consteel process, which at present is considered to be an emerging technique, continuously feeds scrap via a horizontal conveyer system into the arc furnace. The conveyor runs in a refractory lined tunnel, in which furnace off-gas preheats the scrap to between 300 C and 400 C. Additional preheating up to about 900 C can be achieved by fuel burners along the side of the feed tunnel. With this arrangement, the roof of the arc furnace does not need to open, since scrap enters through the side of the furnace.

Secondary metallurgy

The use of secondary metallurgical techniques is now commonplace for EAF steel manufacture. These techniques are described in Section 2.1.9.

Reuse of EAF waste products

EAF dust and millscale contain iron, zinc, lead and cadmium which can be recovered by recycling and treatment, but the feasibility is application specific and costs can be prohibitively high. Recycling millscale is the most economic, e.g. using the Carbofer process to recycle to the furnace; or recycling to a sinter plant if accessible. Operators are seeking economic means to recycle the dusts (so reducing volume) and then recover the zinc. It is feasible to recycle the dust to the furnace, raising the zinc content to circa 30-40% and recover it, e.g. treating in a using a Waelz kiln (a pyrometallurgical process) before feeding to a primary zinc smelter (within certain constraints). This requires preparation (e.g. pelletising or briquetting) and handling, and consumes extra energy (circa 20-30 kWh/t). Recycling all the dust is not possible. Processes exist for recovery from dusts from production of carbon/low alloyed steel (Waelz, ESINEX and others) and dusts from high alloyed steel (ScanDust and

See BREF on Non-ferrous Metals for Waelz process

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

B.U.S processes). About 50% of the EAF dust in the EU is treated by Waelz kilns, i.e. where landfill of the dust is banned. Other processes are in development, which may reduce costs. The main drivers are environmental performance, landfill tax and the availability of landfill capacity.

Furnace and ladle lining repairs

Maintenance of the hearth refractories, particularly at the slag line, is normally carried out immediately after tapping by using refractory gunning techniques. Such repairs to the furnace result in some release of fume. Relining of furnaces and ladles involves wrecking the old linings, which are contaminated with slag, and either recycling of the resultant waste off site or disposal to landfill. The wrecking operation, which is normally carried out using pneumatic or hydraulic machinery in a building, can produce large quantities of dust.

2.1.8.2 Releases

Air:

BREF Sections 9.2.2.1.1 and 2

The production of steel using the EAF process route may produce large quantities of fume (metal oxides of predominantly iron, with zinc, lead and other oxides, including trace oxides of cadmium), together with CO, CO₂ and traces of PCDD/F, PAH, PCB, HF, HCl, benzene and other hydrocarbons.

SO₂ emissions from EAFs do not normally require special consideration. NO_x emissions, although of low concentration, may represent a significant mass emission in the large volume of fume extracted from the furnace.

Water:

BREF Section 9.2.2.3

Water cooling of the furnace shell, roof, fume ducting, electrode arms and transformers normally involves closed circuit cooling systems, which minimise releases to water.

Water run-off from storage areas which may contain oil is treated in an oil separator before discharge.

Land:

The main solid wastes produced by the EAF steel making process are slag and dust. EAF slag can be crushed and screened to recover a size fraction for use as a roadstone aggregate. The dust normally contains significant quantities of metallic oxides and may also contain detectable levels of PCDD/F and PCBs.

Waste:

Waste refractories are generated when the ladles and arc furnaces are relined.

Energy:

EAF furnaces are major energy consumers. The quality of steel is a major factor in energy consumption. The theoretical energy consumption usually lies in the range 350 kW – 370 kW/t, mainly as electrical energy. EAF steel making is only 55% to 65% efficient and as a result the total equivalent energy input is usually in the range of 560 to 680 kWh/t for most modern operations.

Energy saving concentrates on techniques to reduce tap to tap time and increasingly through use of heat recovery such as scrap preheating. Though the latter can increase emissions to air unless preventative measures are taken.

It should be noted that fabric filters can consume the equivalent of 7-10% of the total energy used to melt the steel.

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BREF Section 9.2.2.5

Noise:

Inside an EAF shop, noise levels as high as 133 dB(A) can occur although noise from the electric arc and high velocity oxy-fuel burners should not be significant at the site boundary in most cases. The main potential sources of boundary noise are scrap and product handling, fume extraction, cooling water and water treatment plant.

Accidents:

Environmental risks are primarily associated with feeding inappropriate materials (sealed containers, radioactive material, PCBs, excessive quantities of plastics, etc) and equipment failure, e.g. of abatement equipment.

Note Radioactive substances are covered by the Radioactive Substances Act 1993 not IPPC

Indicative BAT requirements for electric arc steel making (Sheet 1 of 3)	
Control of primary releases to air	
1	The essential requirement is for primary fume control. Furnaces of 30 tonnes or more capacity should employ direct extraction of primary fume through a “fourth hole” in the furnace roof; (‘second hole’ on DC arc furnaces). The primary fume off-take should allow the entry of induced air to ensure complete combustion of any CO released from the furnace. Smaller furnaces may currently have side-draught hoods for primary fume control, though this abatement technique should be replaced by direct extraction where practicable. Partial enclosures or canopies located at likely areas of fume escape can be mounted on, and move with, the furnace roof. Such areas are typically around the electrode ports, the roof ring seal, over the slagging door and above the tapping spout. (BREF Section 9.4 EP.1)
2	Post combustion by oxygen injection should be used to reduce the concentration of combustible gases leaving the furnace and facilitate recovery of some energy value to assist in melting the scrap charge.
3	Oxygen and carbon injected into the furnace for metallurgical reasons and to provide additional chemical energy input will give rise to a marked increase in fume generation. Applicants should demonstrate that increased productivity achieved does not give rise to an increased specific release of pollutants per tonne of liquid steel produced in the furnace.
4	The primary fume is extracted from the furnace through a water-cooled elbow and duct by the exhaust fan(s) of the abatement plant. The fume may be cooled by a forced draught cooler, unless dilution air from a roof canopy is used to reduce the temperature to a satisfactory level for the abatement plant, which is generally a fabric filter. (Dilution air adds to the power requirements of the fume extraction system and may increase the mass emission of fume from the filtration plant). Combustion air enters at the “slip gap” between the furnace elbow and the water cooling ducting, which combusts CO and allows the furnace to tilt.
5	For a new furnace, the fume control system should be included in the original design and based on a furnace enclosure (“doghouse”) or total melting shop enclosure; together with traditional fume abatement plant. Although a furnace enclosure usually provides effective noise abatement and fume containment during the operation of the furnace, the design should also include control of local fume escape during charging and tapping. This is particularly important if the furnace enclosure has doors for crane access. The potential benefits of an enclosure apply to large and small capacity furnaces.

Introduction		Techniques for pollution control			Emissions			Impact			
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Indicative BAT requirements for electric arc steel making (Sheet 2 of 3)

- 6 The design of a new or upgraded fume control system for an existing furnace or for the installation of a new arc furnace within an existing plant will be strongly influenced by the layout and overall situation within the plant. In these circumstances, a furnace enclosure may not be practicable, in which case a modified roof capture system should be considered, involving extension of hoods in the roof space and some sealing of the building roof. Capacity of the fume cleaning system and extract fan would likely need to be increased. In the case of furnaces below 30 tonne capacity, canopy hoods above the furnace and side extraction ducts have commonly been used for collection of primary and secondary fume. However, "fourth hole" extraction is known to be installed on furnaces with as little as 3 tonnes capacity and is considered BAT for all EAFs under PPC.
 - 7 Fabric filters are considered to be BAT for both primary and secondary fume cleaning. (BREF Section 9.4)
 - 8 Emissions of benzene and other hydrocarbons have been linked to the addition of coal, which degasses before being burnt. Any use of coal should be declared in the application, with proposals to phase it out.
 - 9 PCDD/F, PCB and PAH emissions are linked to the presence of non-metallic material such as oils and materials containing chlorine in the scrap. It has been reported that emissions of these species can increase where scrap preheating techniques are used.
 - 10 PCDD/F, PCB and PAH emissions are to be minimised by:
 - controlling scrap quality to give insignificant oil contamination
 - post combustion (also reduces CO emissions) and rapid cooling of the exhaust gases (by dilution or water quenching) to avoid de novo synthesis
 - bag filtration
 - 11 Emissions of PCDD/F should be 0.1-0.5 ng I-TEQ/m³. Operators using the above techniques but having difficulty meeting the benchmark should install equipment to inject activated carbon or lignite before the bag filter.
 - 12 Monitoring of combustion off-gases and post combustion control are required to ensure that effective post combustion is achieved during the variable furnace cycle.
 - 13 The trend towards increased use of chemical energy to boost furnace melting rate generates additional fumes. Applicants should quantify and justify the level of chemical energy used (e.g. increased productivity), since increasing the proportion of energy input chemically can, in some circumstances, increase fume emissions.
- Control of emissions during charging, tapping and slag handling**
- 14 With existing plant, emissions during tapping and slagging should be collected by hoods connected to an extraction and filtration system. The use of local fume enclosures is considered BAT. Where these are not practicable, roof extraction canopies are required in the melting shop.
 - 15 For new plant, total building sealing with extraction designed to ensure acceptable working conditions should be considered as BAT. Building sealing may also be possible in existing large melting shops where redundant furnaces have been decommissioned.
 - 16 The addition of alloying elements and fluxing agents during tapping, when mixing of the steel is good but sometimes collection of the significant fume generated may not be, should be justified in the Application with an assessment of collection efficiency and, if necessary, by comparison with other options; e.g. addition in later stages of steel making.

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Indicative BAT requirements for electric arc steel making (Sheet 3 of 3)

- 17 For large furnaces with eccentric bottom tapping, transfer cars should be used to position the tapping ladles and, where utilised, slag pots. The operation should be well enclosed with a local extraction system installed under the furnace where space permits. The fume from these hoods should be ducted into the primary extraction system.
- 18 Dust and fume should be minimised by discharging slag from the furnace into slag pots, rather than on to the ground.
- Control of releases to water**
- 19 Cooling water systems should normally be closed circuit utilising air blast coolers or evaporative cooling towers. Cooling water blowdown that would otherwise fail to meet the emission benchmark for suspended solids (or local requirements) will need a settlement stage. Works with effluent treatment plants may be able to use the final effluent as make up to the cooling towers. (BREF PI.3)
- 20 Surface water run-off from all areas should have solids deposition arrangements and may require oil separation.
- Control of releases to land**
- 21 The production of slag should be minimised through effective process optimisation and use of high quality raw materials.
- 22 In general, slag from EAF steel production is crushed to recover the metallic content and the residual slag can be sold as a road aggregate or used on site to build roads or noise barriers. See Section 2.1.10. (BREF EP.4)
- 23 However, slag from high alloy and stainless steel may contain hexavalent chromium which could leach into groundwater. Such slag should be securely landfilled.
- 24 Waste refractory is normally disposed of by landfilling. Opportunities to utilise such material should be considered by the Operator in the Application under Section B2.6.
- Reuse of EAF waste products**
- 25 Operators should be working towards recycling millscale and dusts. Applicants should describe any current arrangements for recycling and recovering EAF dusts and millscale. Ferro-alloys should be recovered from dust and scale from stainless steel production. (BREF EP.5)
- 26 If disposal to landfill is proposed then this must be demonstrated to be BAT, taking costs and benefits into account and having regard for recycling options which are in use in the EU and elsewhere.

2.1.9 Secondary steel making

2.1.9.1 Secondary steel making process

“Secondary steel making” covers the processes and treatment of molten steel after tapping of the primary steel making furnace (BOS or EAF) up to the point of casting. Secondary steel making is typically carried out at ladle treatment stations in order to:

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Summary of the activities

- reduce the sulphur and carbon in the steel
- deoxidise the steel
- adjust the chemical composition in other ways

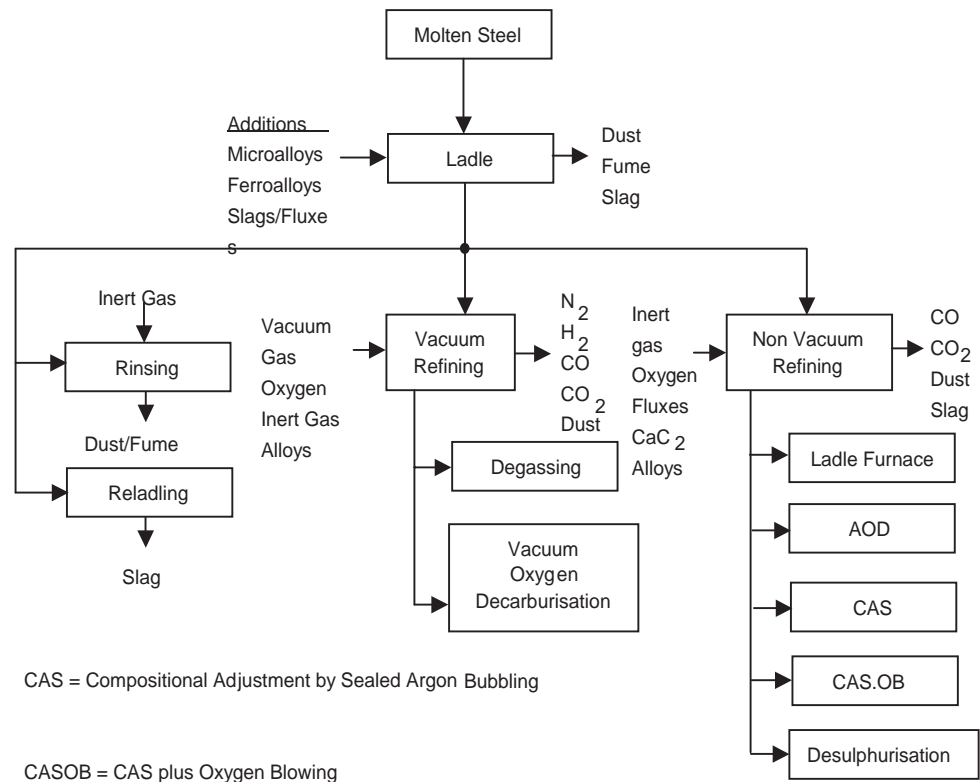
BREF Section 8.1.4

- homogenise or mix the steel
- adjust the temperature for downstream casting operations
- remove undesirable gases such as hydrogen and nitrogen
- remove non-metallic inclusions

A ladle treatment station also acts as a buffer, to enable easier 'sequencing' of ladles at the continuous casting plant.

The ladle of molten steel is usually transferred between stations using an overhead crane or ladle transfer car. There is a range of treatment techniques available, but ladle treatment stations in bulk steel production plants usually involve either a vacuum generating system or arc heating or a combination of both. Other treatment stations employ inert gas, wire feed or powder injection equipment. The range of these processes is shown in Figure 2-7.

Figure 2.7: Secondary Steel Making



Ladle furnace processes

A ladle furnace is similar in principle to an arc furnace, except that the electrodes heat the molten steel in the ladle.

Alloying and micro-alloying agents used in secondary steel making include: aluminium, manganese, silicon, magnesium, calcium, cerium, molybdenum, tungsten, nickel, vanadium, chromium, lead, boron, titanium and niobium. Additives are usually introduced either as ferro-alloys or elementally.

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Pneumatic injection systems are also used for certain refining processes, using argon or nitrogen as a carrier gas and a refractory-clad lance for subsurface injection of the reagents into the melt. The types of reagents used include:

- lime and lime-fluorspar mixtures to remove sulphur and phosphorus
- calcium carbide and calcium silicide powders to remove sulphur and modify the sulphide inclusions
- micro-alloy powders to improve the mechanical properties of the finished products
- injection of lead shot to produce steel with good machinability

These latter operations are normally carried out at a dedicated lead addition station or at the ladle furnace station. The attention of the Regulator's staff is drawn to the potential fume generation of this process and the special precautions necessary.

Vacuum treatments

Secondary steel refining can involve placing the ladle inside a vacuum degassing facility (e.g. RH or DH degasser) to remove dissolved hydrogen and nitrogen. Oxygen is removed using solid deoxidants, with some of the oxides floating out during degassing.

Vacuum oxygen decarburising (VOD), which is used for stainless steel production, involves injecting oxygen through a lance into a ladle of molten steel under vacuum conditions in a sealed vessel to oxidise the carbon to low levels. Carbon can be reduced to very low levels in this batch process.

Vacuum arc degassing (VAD) is a process in which a ladle furnace is operated under vacuum conditions, thus providing a facility to heat, degas, add alloys and treat the slag in a closely controlled environment.

Non-vacuum treatments

The argon-oxygen decarburisation (AOD) process is used for decarburising low-carbon stainless steel and nickel alloys and is carried out in a converter vessel, similar in design to a BOS vessel. Initial melting is carried out in an electric arc furnace. The melt is then transferred by ladle and poured into the AOD converter, where the argon-oxygen gas mixture is injected into the bath through tuyeres. The refined stainless steel and slag are tapped off by rotating the converter. High-temperature off-gas, containing a significant quantity of carbon monoxide, is generated. The carbon monoxide is combusted as it leaves the vessel.

There are variants to the conventional AOD process, such as the CLU (Creusot Loire-Uddeholm) furnace, where steam is injected as a partial substitute for argon during part of the steel making cycle.

Induction melting

Induction melting in air is used in the manufacture of a wide range of alloys and ferro master alloys. The process, which is operated on a batch basis, consists of a tilting refractory-lined crucible or rammed monolithic lining, surrounded by a water-cooled, electric induction heating coil. Additions are made and a slag produced to remove unwanted impurities. The charge normally comprises recycled scrap, remelt ingot, alloying additions and fluxes. The process is primarily a melting and alloying operation and is only capable of carrying out limited refining.

Vacuum induction melting

The vacuum induction melting (VIM) unit consists of a vacuum chamber containing the furnace, with facilities for making alloy additions and casting. Induction melting under vacuum is used in the manufacture of complex super-alloys and nickel-based alloys. If required, such alloys can be subsequently refined by electroslag remelting or vacuum arc remelting processes, or a combination of both, to achieve the required metallurgical and mechanical properties.

Vacuum induction melting can also be used to manufacture nickel/cobalt master alloys without further refining. The entire operation, including melting, making additions, sampling, tapping and casting, is carried out under vacuum, and produces either ingots for hot working or electrodes for remelting.

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Vacuum arc remelting

In this process, a steel ingot electrode is continuously remelted by means of a DC arc passing between a water-cooled copper mould and the ingot under a vacuum of around 0.15 mbar or below. The electrode melts and falls as droplets into the mould, where it solidifies. No slag is involved. The controlled slow solidification improves the directional structure of the re-cast ingot and increased purity is achieved.

Electroslag remelting

This process involves remelting an ingot into a water-cooled copper mould at atmospheric pressure. The melting process is by AC or DC resistance heating of a liquid synthetic slag held between an electrode and the surface of the ingot to be remelted. The slag comprises a mixture of mainly fluorspar, with some lime and alumina. As the alloy melts, droplets fall through the slag and collect as a pool in the bottom of the mould. Reactions between the slag and the metal enable the metal to be refined, with particularly good removal of oxide particles and non-metallic inclusions.

Ferrous alloy powder/shot production

The water atomisation method of manufacturing ferrous powder/shot involves charging raw materials into an induction or arc furnace for melting to the required specification. The resulting molten metal is poured into an atomiser, where it is blasted with high-pressure water. This forms an aqueous slurry of powder/shot, which is allowed to settle in a collection tank. The product is dried, blended and sieved.

The gas atomisation method of ferrous powder production involves the melting of a charge of raw materials in either an induction furnace at atmospheric pressure or a vacuum induction furnace. The resulting molten metal is atomised into fine droplets by supersonic jets of nitrogen or argon gas. At the bottom of the atomising tower, solidified powder and gas are extracted to a gas separator, where the bulk of the powder drops into a collector. Any fine particles are removed from the process gas by cyclone. The powders are then blended and sieved.

Ferro master alloy production

Manufacture of ferro-boron is achieved by the carbon reduction of boric oxide using an open-top DC electric arc furnace. In one instance, wood shavings are used as a reductant in the DC arc furnace. The ferrous material is charged to the furnace via a vibrating feeder. The molten metal is cast into small ingots. Ferro-titanium is manufactured by melting ferrous and titanium scrap in an induction furnace at atmospheric pressure.

2.1.9.2 Releases

Air:

Secondary metallurgical techniques can produce large quantities of metallic fume.

Water:

Liquid ring pumps and steam ejectors are a possible source of water contamination when using vacuum treatment processes.

Land:

Relatively small quantities of slag and dust are produced. Waste refractory is generated when ladles and other equipment handling molten metal are relined.

Ferro-alloys are covered in separate guidance on Non-ferrous Metals

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Indicative BAT requirements for secondary steel making (Sheet 1 of 2)

Control of releases to air

Ladle treatment (non-vacuum)

- 1 Fume generated by a ladle furnace should be collected with a refractory-lined or water-cooled hood incorporated into the roof of the furnace, feeding a fabric filter, which may be separate or common to the fume cleaning system of the EAF/BOS plant. Where decarburisation is undertaken in the ladle, high fume temperature will be experienced and fume cooling should be included to protect the downstream fabric filter plant.
- 2 Similarly, fumes emitted during steel desulphurisation should be captured with a specially designed hood or lid placed over the ladle, with extraction to a dedicated bag filter system. Appropriate means should be provided to prevent release of dust to air during the transfer and storage of reagent powders.
- 3 Fabric filters are considered to be BAT for the treatment of emissions to atmosphere from non-vacuum secondary steel refining plants. It is important that the hood is well designed and the extraction volume is adequate for the application. In the argon-oxygen decarburisation (AOD) process, an extraction hood, which can be water-cooled or refractory-lined, captures fume at the mouth of the converter vessel. The fume generated, together with induced air, is extracted through the hood. The excess air combusts the CO arising from the process and also provides some cooling by dilution. The fume temperature is reduced by heat losses to the water-cooled ductwork of the fume extraction system. However, in order to protect the bag filter plant, further air dilution or a heat exchanger will normally be required.

Ladle treatment (vacuum)

- 4 Fumes or gases arising from the VOD or VAD processes should be extracted via an indirect cooler into the vacuum system, which acts as a wet scrubber. The cleaned fume is then exhausted to atmosphere by a stack. BAT for vacuum generating equipment utilised in bulk vacuum secondary refining is either multi-stage steam ejectors or a combination of ejectors and water ring pumps. These systems are the most effective method for achieving the required operating vacuum and minimising emissions to air and water.
- 5 The vacuum oxygen decarburisation (VOD) process may require the installation of a burner system in the stack, in order to avoid the discharge of high levels of CO.

Electroslag remelting

- 6 An effective capture system for removal of particulate matter from the fume generated during electroslag remelting should be installed and ducted to a fabric filter. Filter bags should be pre-coated with lime to capture HF, which is generated from the calcium fluoride present in the slag.

Special alloy processes

- 7 Induction melting equipment and DC furnaces for manufacturing ferro-alloys should incorporate a movable hood linked to a fume extraction duct and bag filter system. These processes may use wood shavings as a reductant and can produce substantial amounts of fume.
- 8 In the case of production of ferro-alloy powders by gas atomisation, a gas/powder separator should be followed by a suitably designed cyclone collector for final capture of small particles. Particulate matter emitted during the processing of alloy powders should be collected by a hood and captured by a fabric filter. Pyrophoric powders may need to be vented through a wet scrubber or irrigated cyclone or other safe system.

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Indicative BAT requirements for secondary steel making (Sheet 2 of 2)	
Control of releases to water	
9	Any surface water run-off should have solids deposition and oil separation arrangements.
10	Any discharge of water from cooling systems or steam ejectors should be treated by settling/clarification before release.
Control of releases to land	
11	Most slag from secondary metallurgy is processed for iron recovery and is then landfilled. Waste refractories are normally landfilled. Fume dust from leaded steel production should be sent for lead recovery, if a recovery process is available.

2.1.10 Slag handling and processing

2.1.10.1 Slag handling processes

Summary of the activities

Iron making slag

In modern blast furnace operation, around 250 kg of slag is produced for every tonne of iron. The molten slag may be processed in a number of ways, depending on market demands for the by-product materials and slag processing facilities available.

The majority of slag is processed into granulate. In this process the slag tapped from the furnace is poured on to a jet of water to granulate the molten slag, which falls into a tank where cooling continues. The granulate is dewatered and the process water cooled in a recirculating cooling system. The resulting product, which has a high moisture content, is dried and subsequently ground for use mainly as a pozzolanic cement for concrete.

Lower quantities of slag is tapped directly into pits where, after air and water cooling, it is crushed for use as aggregate in road and rail construction, as a sewage bed filtration medium and as back-fill material..

Expanded or pelletised slag is produced by pouring molten slag on to a water-sprayed revolving drum, which is designed to throw the semi-molten slag into the air for sufficient time to allow it to form a pellet. This process uses less water than slag granulation and produces a product that can be used for fire-resistant wall panels, insulating bricks and structural infill.

A number of dry or semi-dry slag processing techniques are under development but are not yet commercially proven.

BOS slag

Some 100 kg of BOS slag is produced per tonne of liquid steel. Slag from the BOS process is usually poured directly into slag pots and transported to the slag processing area or poured into slag pits and then removed. The slag is tipped in specially prepared pits where it is cooled with water. Slag breaking and cutting of skulls with oxygen lances for metal recovery can create dust and fume.

After crushing and processing to recover steel entrained in the slag, the material is less useful than blast furnace slag because of its chemical composition and mechanical characteristics. Some BOS slag is recycled to the blast furnace and the sinter plant to recover the lime and combined iron, and

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limited markets have been developed to use the material as a general aggregate (e.g. as rail ballast) as well as in roadstone, after weathering. BOS and secondary steel making slags that cannot be utilised in such markets are landfilled. BOS slag comprised 67% of material landfilled by Corus in 1999.

EAF steel making slag

Slag is poured from the furnace either into pots or on to the ground below the furnace. When slag pots are used, these are normally transported by road on purpose-built heavy-duty mobile carriers to a slag tipping area. Dust and fume may be generated during slag tipping but this can be controlled. The molten slag is normally cooled with water sprays and after solidification, the slag is recovered by an excavator, prior to crushing, screening and magnetic separation to recover scrap metal for recycling and slag for sale. Slag breaking and cutting of skulls with oxygen lances for metal recovery can create dust and fume.

Some EAF slags may contain a high proportion of lime. EAF slags are usually “weathered” in the open air for a period of at least a few months to hydrate the free lime before use as roadstone or other construction material.

2.1.10.2 Releases

Air:

Significant quantities of fume can be released during handling of the various types of slag. This can occur during the tipping of molten slag, and the breaking and crushing of solidified slag. The main pollutants are dust, fume and, in the case of blast furnace slag, also SO₂ and H₂S. Slag from stainless steel manufacture disintegrates as it cools, giving a friable white dust (“falling slag”) which is easily caught by the wind, reaching off-site receptors.

Water:

The recirculating water of granulation plants for blast furnace slag becomes strongly alkaline and contaminated with suspended solids and a range of dissolved species.

Fresh slags can release sulphates, lime and, in the case of EAF slags, metals in the leachate.

Land:

Slag that cannot be processed for re-use or commercial applications is disposed of to landfill.

Noise and vibration: BOS slag can cause steam explosions if tipped onto wet ground; or if water leaks into the slag pits; or if excessive water is used for cooling. These explosions cause noise and vibration, which can lead to complaints, (see Section 2.9).

Indicative BAT requirements for slag handling and processing (Sheet 1 of 4)

Control of releases to air

Iron making slag handling and processing

- Slag granulation processes are generally preferable to traditional slag cooling methods from the environmental viewpoint, because the process can be enclosed, less water is consumed and more of the sulphur remains in the slag rather than being emitted. Fume capture and total condensation should be used on new plant; and retrofitted to existing slag granulation equipment if odour is experienced. Care is required to avoid producing mineral fibres (“angel hair”). (BREF EP.6)

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for slag handling and processing (Sheet 2 of 4)

- 2 Pelletisation is a crude form of granulation, with a lower water-to-slag ratio, which can be more effectively controlled than traditional slag pit cooling from the environmental viewpoint. There are significantly fewer examples of slag pelletisation processes than modern slag granulation plants, which are used throughout the world. It is not considered BAT for new plants.
 - 3 Air cooled slag, granulated slag and pelletised slag each have different properties making them suitable for different markets. However, because of the sulphur releases and odour risk from air cooled slag, granulation processes are considered BAT for new slag treatment facilities. Operators should exploit granulation processes to the maximum extent permitted by the market.
 - 4 There are developments towards a dry air-cooled granulated slag process (i.e. granulation in air, with no water-cooling). Since a dry granulating process could offer environmental benefits. Operators and the Regulator's staff should keep this development under review.
 - 5 While hot, the sulphur in the blast furnace slag reacts with air to release SO₂. When water is added, H₂S is produced by the reaction of water on hot CaS and MnS. It appears that controlling the pH of the cooling water to between 7.5 and 9.5 may inhibit this reaction, which can be particularly significant in slag pit cooling. There is, however, a general shortage of knowledge on the quantities of pollutants emitted from slag pit cooling and of the methods that will most effectively control such emissions. Since slag pit cooling will continue to be used for some time, Operators should investigate and recommend improved methods of pollution control.
 - 6 Water used for quenching should be free from substances such as ammonia, which may give rise to odorous or toxic fumes. This should be taken into account when developing the overall water treatment and recycling strategy, (see Section 2.3.18).
- BOS, EAF and secondary steel making slag handling**
- 7 Different types of slag arise during the BOS steel making process. The largest amount, known as BOS slag, is produced in the converters. Smaller quantities of other slags, with different properties, are produced during the hot metal pre-treatment and secondary steel making processes. Desulphurisation slag is particularly friable and can be a source of kish.
 - 8 In circumstances where traditional tipping and excavation of solidified slag take place within the steel plant building or in the open air, Operators should use appropriate techniques to minimise the emission of fume and dust and the impact of such emissions.
 - 9 Typical EAF slags can be tipped and excavated without significant emission. However, some secondary slags contain a high proportion of lime which give rise to a "falling slag" and may result in white dust complaints in the vicinity of the steel works. Additives, such as borax, have been developed for adding to secondary steel making slags to inhibit falling slag formation.
 - 10 Any secondary steel making slag which has a propensity to produce significant airborne dust should be tipped in an enclosure (this could be the furnace building); equipped with dust extraction and abatement if that is necessary to prevent significant releases. This is particularly important if tipping takes place close to a sensitive area. For example, where desulphurisation slag is a source of kish transporting off-site, then containment and abatement is required.
 - 11 Where dust emissions are an issue, a system of assessing emissions (after abatement) from each slag tipping operation is required, e.g. recording emissions on a scale of 0 – 4 (none to very high). Photographs can be used provide a reference for consistent grading. A thermal imaging technique may be used to assess the dust plume generated by slag tipping in the open.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for slag handling and processing (Sheet 3 of 4)

Metal recovery

- 12 Any oxygen cutting should be undertaken in an enclosure with effective fume collection and abatement with a bag filter.

Control of releases to water

- 13 Where water-cooled blast furnace slag pit methods cannot be replaced by alternative technology such as slag granulation, the water used should be collected and recycled. This can be difficult due to the “cement-like” characteristics of the solids.
- 14 Apart from contamination by suspended solids, the water used for slag processing can become strongly alkaline by solution of the free lime. Depending on the source of the slag, the process water can also become contaminated with other dissolved species.
- 15 The wastewater from blast furnace slag processing should be treated by pH correction and settlement. Biological treatment may also be necessary to meet local water quality requirements.
- 16 Leachates from slags may contain sulphur, calcium sulphide and polysulphides (increasing pH towards 12), metals and other contaminants – depending on the nature of the slag and weathering history. Some heavy metals have been found to leach from some EAF slag. Requirements of the Groundwater Regulations must be considered (see Section 2.4). Releases to ground water need to be assessed and appropriate monitoring instituted where necessary.

Control of releases to land

- 17 Slags from iron and steel making are regarded as by-products that have potential commercial value. The actual value and degree of commercial exploitation strongly influenced by the market for each secondary product/by-product and economic instruments of Government policy, such as the Landfill Tax. Operators should seek opportunities for utilisation of such by-product materials.
- 18 Generally, there is a good market for blast furnace slag products in the UK, subject to transport costs and availability of alternative materials.
- 19 The ability to recycle a proportion of the BOS slag to the blast furnace is limited by the presence of elements such as phosphorus. Since all the phosphorus charged to the blast furnace is reduced into the hot metal, the phosphorus content of the iron would progressively increase if too much phosphorus-rich BOS slag were recycled to the blast furnace. (This could jeopardise the specified chemical composition of certain steels).
- 20 Whilst the metallic Fe entrained within the BOS slag is recovered by crushing, followed by magnetic separation, continued effort should be made to route the remaining residual slag away from disposal by landfill. It contains more free lime and magnesia than some other slags, which causes expansion on weathering. Potential alternative routes include the use of BOS slag as a fertiliser additive or soil conditioner and use as a construction material, after ageing to hydrate any free lime.
- 21 Depending on chemical analysis, EAF slag can be recycled as a civil engineering aggregate or roadstone, after an appropriate period of weathering, or it may be used as an additive by the cement industry.
- 22 Slag from stainless steel production generally has a high CaO/SiO ratio. This makes it less attractive than most EAF slags in terms of use in construction. It tends to be landfilled after metal recovery. The slag can contain elevated levels of Cr VI so landfill sites must be adequately sealed to prevent leaching of chromate ions.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for slag handling and processing (Sheet 4 of 4)

Assessing emissions from slag tipping

- 23 It is necessary to assess emissions from slag tipping in determining how to minimise emissions and whether to use containment and abatement. A thermal imaging camera can be used to assess the fume generation during slag tipping operations that may not be visible to the human eye.

Emerging technology

- 24 The development of dry slag granulation plant should be kept under review.
- 25 For new plant, the so-called "slagless steel making" processes should be considered. This involves pre-treatment of the blast furnace hot metal to remove silicon and phosphorus, prior to decarburisation in the BOS converter.

2.1.11 Continuous casting

Table 2.6: Continous castors

Works	Machine type	No of strands	Capacity (as cast) kt/ week
Celsa, Tremorfa	Billet	6	12.5
		6	10.5
Thamesteel, Sheerness	Billet	4	13
Alpha Steel, Newport	Billet	4	9
	Billet	4	9
	Slab	4	9.5
Outokumpu Sheffield Ltd	Slab	1	15
	Billet	4	
Corus UK Ltd, Teesside	Bloom	8	24.5
	Slab	2	48
	Slab	2	
Corus UK Ltd, Scunthorpe	Slab	2	23.5
	Bloom	4	21.6
	Billet	8	12.7
	Bloom	6	24.5
Corus UK Ltd, Port Talbot	Slab	2	68.8
	Slab	1 (split mould)	
Corus UK Ltd, Rotherham	Bloom ¹	4	23.5

Note 1. Two independent twin strand machines

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

BREF Section 8.1.5

Process:

The continuous casting process produces semi-finished products, such as slabs, blooms and billets. It has generally replaced the production stages of ingot casting, soaking pits and primary rolling mills, with resulting improvement in yield, energy consumption and operating costs. Molten steel is fed at a controlled rate into a water-cooled copper mould of appropriate cross-section. As the molten steel cools and forms a solid outer skin, it is drawn from the mould and is cooled by secondary water sprays, prior to discharge onto a roller table, where it is cut to the required length. Depending on the cross-section of the product, continuous casting machines normally have from one to eight strands. The cast product is normally of square or rectangular section, though “dog-bone” shapes can be cast for rolling heavy section beams and round blooms are cast for manufacturing seamless tubes.

The molten steel is fed from the casting ladle into a tundish that acts as a reservoir to provide a constant ferrostic head and as a distributor for multi-strand casting machines. Shroud tubes or inert gas shielding may be used between the ladle and tundish, and between the tundish and mould to limit the contact of the stream of molten metal with air. The steel begins to solidify in the copper mould, forming a shell, with a molten core. To prevent the solidified shell sticking to the mould, mould lubricant powder is added and the mould is oscillated in the direction of casting at a speed greater than the casting speed. After the point where solidification is complete, the strand is cut to the required length using automatic oxy-gas cutters. In the case of stainless steel, iron powder is injected into the oxy/propane flame to improve the cleanliness of the cut.

Air:

Small amounts of metal fume are released during the continuous casting operation.

Water:

The primary cooling water for the moulds and caster machinery is supplied by a closed circuit, which uses high-quality water. There are normally no releases to water from this circuit, apart from blow-down in the case of evaporative cooling systems and during major maintenance, when the cooling system may be drained. There may also be leaks from the system, at rotating joints, etc.

Releases to water from the recirculating cooling and treatment plant of the secondary spray cooling circuit comprise solids, in the form of scale, and oil/grease.

Land:

Scale is produced during the casting process, which is normally recovered for recycling.

Waste refractory material is generated when tundishes are relined and submerged entry shrouds/nozzles are replaced.

Indicative BAT requirements for continuous casting (Sheet 1 of 3)

Control of releases to air

- 1 To enhance the quality of the finished product, the streams of molten steel between the ladle and tundish and between the tundish and mould are normally shielded from contact with air. This shielding has the added benefit of reducing fume generation.
- 2 The oxy-gas cutting equipment used when cutting stainless steel is fed with iron powder. This produces sufficient brown fume to justify fitting fume extraction and abatement equipment.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for continuous casting (Sheet 2 of 3)

Leaded steels

- 3 When casting leaded steels or when making lead additions, the top of the ladle and tundish should be covered. Careful consideration of injection plant design is required to minimise the risk of releasing lead fume. Fume collection should be provided around the mould area and for the secondary steelmaking unit itself, with extraction to a fabric filter dedicated to treating lead-bearing fume.
- 4 If oxygen lancing is used to clear the ladle nozzle, the fume should be confined and extracted, together with the other lead-bearing fumes.
- 5 Ladle cleaning, wrecking and repairing areas should be provided with dust control and collection equipment.
- 6 When cutting leaded steels, oxy-propane cutters should be fitted with a travelling enclosure to extract fume into the lead extraction system. All dust and fume within a leaded steel casting area should be captured by a dedicated bag filter unit. Collected lead fume should be kept in sealed and marked containers and disposed of to a lead refinery for recycling or other safe disposal route authorised by the Regulator.

Control of releases to water

- 7 The “closed” cooling circuit normally has a primary circuit rejecting heat to a heat exchanger, and a secondary circuit, which cools the heat exchanger and rejects heat to atmosphere. The secondary circuit has a purge to control the concentration of dissolved solids as the water is evaporated. The purge can be minimised by using good-quality make-up water and by attention to water treatment to minimise fouling and corrosion. Care should be taken to ensure that any additives such as biocides and scale/corrosion inhibitors are minimised and that control systems and operational practices are designed to minimise the risk of accidental releases of such chemicals. (BREF Section 8.3 EP6)
- 8 The recirculating “open” cooling water circuit becomes heavily contaminated with the scale removed during casting. The water can also become contaminated with tramp hydraulic oil, lubricating oils and grease escaping from the process equipment. The spray cooling water is discharged from the machine into a scale pit, which captures the heavier scale and then passes to a clarification system for settling the finer particles of scale, which can be contaminated with tramp oil. The spray water is commonly polished by sand filtration prior to or after cooling in an evaporative cooling tower. Sand filtration helps to ensure low levels of particulate and oil contamination to achieve satisfactory prolonged operation of the secondary spray nozzles of the casting machine.
- 9 If sand filters are employed, equipment to recover the backwash water should also be installed.
- 10 The bleed from the open circuit to control the level of dissolved solids should be taken from downstream of the sand filtration plant to minimise the discharge of suspended solids and any oil/grease contamination.
- 11 Effective oil separation and removal is essential at both the scale pit and, more importantly, the clarification system of the open cooling circuit. Operating management should adopt appropriate procedures to monitor oil consumption and control leakage from the continuous casting plant.
- 12 Specific pollution prevention systems to be identified in the Application.

Control of releases to land

- 13 Scale is removed from the open cooling circuit at various points, including the scale pit, sedimentation tanks, clarifiers and from the backwash recovery system of the sand filtration plant.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for continuous casting (Sheet 3 of 3)

- 14 This scale is normally relatively free from oil, unless abnormal leaks occur. In the case of integrated steel works, the scale can be recycled at the sinter plant or, in the case of EAF plants, either recycled to the arc furnace or sold to other outlets, such as cement manufacturers or sinter plants within the company.
 - 15 Waste refractory is normally landfilled.
- Emerging techniques**
- 16 “Near net shape” casting techniques and thin slab casting techniques are being increasingly applied throughout the world, particularly when new plants are being constructed or existing plants modernised. In such processes, a product that is nearer to the finished shape is produced in the casting machine and directly rolled to the finished product without the roughing mill stage and minimal or no reheating. “Near net shape” casting techniques operate successfully at a growing number of plants worldwide and should be considered as an available technique for new plant.

2.1.12 Ingot casting

BREF Section 8.1.5.2

Process:

Ingot casting is the traditional method of forming molten steel into a solid shape for further processing. Continuous casting has largely replaced ingot casting within Western Europe, except in special circumstances such as the production of large forgings or small quantities of special steels.

Ingot casting involves pouring molten steel into open-top cast iron moulds, the dimensions of which depend on the final product and process route. The moulds may be filled from the bottom or the top and may be connected together through a runner system, so that a number of moulds can be filled simultaneously from a single pouring point. The moulds are usually pre-coated with a proprietary compound to facilitate removal of the ingot from the mould and may be part lined with refractory tiles to improve the internal metallurgical structure of the ingot on solidification. Dust is created during stripping of ingots from the moulds and runners and also when ingots are dressed to remove surface defects using oxygen lances or mechanical grinding.

Air:

Metallic fume may be released during ingot casting.

Indicative BAT requirements for ingot casting

- Control of releases to air**
- 1 Shrouds should be used to protect the molten stream from oxygen contamination and reduce fume production to an insignificant level. If significant fume generation cannot be avoided, then fume collection and abatement should be used. As in the case of continuous casting, dedicated fume extraction equipment and cleaning is essential for leaded steels.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.1.13 Scarfing

Process:

Surface rectification of semi-finished products such as slab and bloom is performed by grinding or scarfing. Grinding is typically used for cold surface conditioning of ingots and slabs prior to reheating and rolling and is carried out either manually or by machines. Billets for special products such as cold heading qualities are usually surface conditioned by machine grinding.

Scarfing involves the removal of a thin surface layer of the slab or bloom by localised melting using an oxy-fuel flame. The flame rapidly melts the steel surface, blowing it away as the burner head automatically traverses the feedstock or vice versa. The scarfing head contains a number of flame cutting nozzles, which are designed to adjust to accommodate different size workpieces. After passing the scarfing head, the conditioned surface is scoured by water jets in order to remove the scale. The operation generates large volumes of moist iron oxide fume.

Spent water and slag are collected in a flume beneath the scarfing machine and are either treated in a dedicated water circuit or transferred to the water treatment plant of a nearby mill or continuous caster. The saturated fume produced by the scarfing operation is extracted, cleaned by a wet electrostatic precipitator or fabric filter plant and discharged to atmosphere via an exhaust fan and stack. In the case of fabric filters, care should be exercised to minimise the risk of “blinding” the filter media with moist fume. In some cases, reheating of the fume above the dew point may be necessary to avoid the risk of blinding.

Depending on the type of product and quality requirements, blooms or slabs can be “hot scarfed” after leaving the primary mill or continuous caster, prior to entering the finishing mill. Alternatively, the blooms or slabs can be allowed to cool for inspection before selective hot or cold scarfing to remove identified surface defects, such as cracks, scale inclusions or seams.

Scarfing can remove defects to a depth of around 4mm, although it is not always economic to cut to the depths required to remove the deepest inclusions. The metal loss due to scarfing is typically of the order of 2-3%.

Air:

The main releases to air from the scarfing process are particulate fume and combustion products.

Water:

Releases to water, which is transferred to the water treatment plant, comprise solids in the form of scale and sludge.

Land:

Scale and sludge are removed from the recirculating cooling water system.

Indicative BAT requirements for scarfing (Sheet 1 of 2)

Control of releases to air

- 1 The Operator will seek to minimise surface defects but some rectification by scarfing may be required. Scarfing using oxy-fuel torches can produce dense brown fume. It can be undertaken by machine or by hand. If emissions are insignificant then no abatement is required, otherwise it should be carried out in dedicated areas with extraction to fabric filter units.
- 2 BAT for the treatment of the wet corrosive fume containing a high proportion of sub-micron particulates generated by a hot scarfing machine is either a wet electrostatic precipitator or media filter, which may need to be protected against blinding.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for scarfing (Sheet 2 of 2)

3 Continued efforts to optimise the continuous casting process may eventually lead to scarfing being mainly restricted to the feedstocks used for the highest surface quality rolled products.

Control of releases to water

4 The "Scour" water circuit becomes heavily contaminated with scale and slags removed during the scarfing operation. The spent water usually passes from the flume into a scale pit, which captures the heavier scale and slag. The water should then transferred to the treatment plant of the scarfing facility or the water treatment plant of the associated continuous casting plant or rolling mill.

Control of releases to land

5 Scale and sludge recovered from the water system should be recycled back to the steel making process where practicable.

2.1.14 Skull burning

Process:

Solidified ferruginous material from furnaces, slag pots, ladles, tundishes and scrap ingots are cut up to handleable sizes, in order to facilitate recycling and disposal. Thermic or oxygen lances are often used, producing large volumes of dense brown metallic oxide fume. In the past, this work was carried out in the open air at a remote part of the site. Containment and/or abatement is now required.

Air:

The main releases from skull burning operations are iron oxide fume.

Indicative BAT requirements for skull burning

Control of releases to air

- 1 It is in the Operator's interest to minimise metal carryover with the slag. Skull formation can also be minimised through the use of a proprietary releasing agent (such as Prism 2000). The skulls and other material should be broken down into manageable sections by drop balling. The weight and drop of the ball should be maximised to minimise the need for cutting.
- 2 The lancing operation should be carried out either in a building or movable enclosure, using appropriate extraction and abatement facilities. Skulls should not be cut if they do not fit properly inside an effective containment. The Operator should investigate the parameters that minimise the production of fume (e.g. speed of cutting); and arrange the cutting to minimise any risk of escaping fume.

Control of releases to land

- 3 Iron oxide recovered from the fume abatement should be recycled, e.g. to the sinter plant.

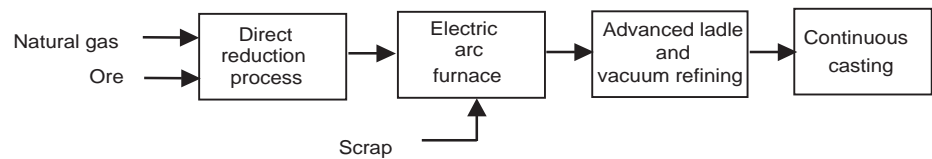
Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.1.15 Direct reduction iron making

There are two iron making processes which can replace technologies currently used in the UK. These are Direct Reduction (DR) and Smelting Reduction (SR) processes. DR uses a fuel to directly reduce iron, which can then be fed to an EAF or possibly a BOS plant. SR uses coal to smelt reduce iron, which can be fed to a BOS plant.

BREF Section 11

Figure 2.8: Steel making based on direct reduction



Process:

DR produces solid primary iron product (see Figure 2-8) called Direct Reduced Iron (DRI). Typically undertaken on iron ore pellets or lump in a rotary kiln, or fines in a fluid bed or rotary hearth furnace. DR has a metallisation rate of >92% and a carbon content of <2%. Alternatively, iron carbide can be produced, at about 90% Fe₃C and 6% carbon. The DR approach has been commercialised since the 1970's; the largest process is the MIDREX shaft furnace producing 22.9 Mt/a of DRI or Hot Briquetted Iron (HBI). The DR-EAF route offers advantages in terms of flexibility and lower capital cost than the blast furnace/BOS route. However, economic viability depends on price, quality and availability of scrap (its main competitor) and the cost of natural gas, the usual fuel. DR plants are relatively small in scale compared to blast furnaces and are only economic where a cheap source of natural gas is available. Little emission data is available.

Air:

Releases from the gas-based direct reduction plant are generally low, with particulate releases to air after abatement in the order of 10 mg/m³. Dust is usually collected with a wet scrubber.

Water:

Cleaning of the process gas with wet technology leads to an aqueous waste stream, although this can be minimised by good water management practices.

Land (& energy):

DRI contains some gangue which increases power consumption of the EAF and gives additional slag requiring recycling or disposal.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for direct reduction iron making

Control of releases to air

- 1 Applicants should consider cleaning the gases in a bag filter. If this is not practical, a wet scrubber may be used.

Control of releases to water

- 2 If a wet scrubber is necessary, settling and recycling of the process water is required. Any aqueous discharge should be justified.

Control of releases to land

- 3 The viability of recycling collected fines to the furnace should be considered.

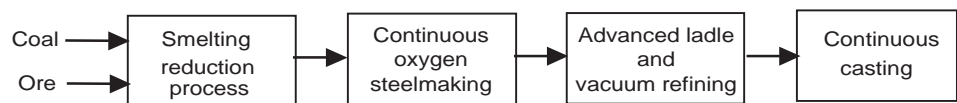
Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.1.16 Smelting reduction processes for iron making

BREF Section 11

Smelting Reduction (SR) uses coal directly as a reducing agent and may in future replace blast furnace technology, rendering coking and possibly sinter plants unnecessary. A number of processes are under development, one of which, the COREX process, is in commercial operation at 750,000 and 300,000 t/ a scale. Five further plants are planned at 600-800,000 t/a scale.

Figure 2.9: Steel making based on smelting reduction of iron



Process:

SR produces liquid iron or (in some cases) steel product (see Figure 2-9). SR has the advantages of small flexible units, with few restrictions on raw materials and lower capital costs than a blast furnace. However, SR cannot use fine ores and economics are very dependent on fuel cost. The COREX process is a combination of two separate processes, comprising the direct reduction of iron ore in an upper shaft furnace and the generation of the reducing gas, from coal, in the smelter gasifier unit. Processes in development include Hismelt, DIOS, AISI-DOE/CCF and ROMELT.

Air:

The COREX process produces a fuel gas with < 5 mg/m³ particulate and 10-70 ppm H₂S. The gas contains no hydrocarbons and only minor levels of nitrogen compounds.

Water:

Cleaning of the COREX fuel gas is based on cyclones and wet scrubbing.

Land:

COREX cyclone fines and sludges can be recycled to the melter gasifier, with a small stream to landfill. A slag is produced, containing most of the sulphur.

Energy:

The COREX process has a high specific coal consumption and produces a relatively large flow of medium calorific value fuel gas (since it is oxygen-blown). The use of the fuel gas largely determines the energy efficiency and process economics. Some of the developmental processes are more energy efficient than the sinter/coking/blast furnace route.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for smelting processes for iron making

- 1 Basing iron making on the blast furnace route may not be justified in future. Applicants should monitor SR developments and justify their selection of sintering/coking/blast furnace or SR route in applications.
- 2 Currently, only the COREX process is commercially available. BAT for a COREX process is basically as follows:
 - Control of releases to air**
 - 3 Cyclones and wet scrubber to give a fuel gas containing < 5mg/m³ particulate loading.
 - Control of releases to water**
 - 4 Scrubber water to be clarified and recycled. Closed circuit cooling water systems.
 - Control of releases to land**
 - 5 Scrubber sludge to be recycled to the melter gasifier or cement industry. Uses for the slag should be sought. Any landfilling to be justified.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.2 Emissions control

2.2.1 Point source emissions to air

The nature and source of the emissions expected from each activity is given in previous sections and the inventory of emissions should be confirmed in detail in the Application.

In general they comprise:

- SO_x, NO_x, particulates, CO_x, PCDD/F and PAH from sintering, coking, iron and steel making
- heavy metals from sintering, iron and steel making

Cross-sectoral guidance on abatement techniques for point source emissions to air can be found in [Ref 9](#).

Indicative BAT requirements for the control of point-source emissions to air (Sheet 1 of 2)

- 1 The benchmark values for point source emissions to air listed in [Section 3.2.1](#) should be achieved unless alternative values are justified and agreed with the Regulator.
- 2 The main chemical constituents of the emissions should be identified, including VOC speciation where practicable.
- 3 Vent and chimney heights should be assessed for dispersion capability and an assessment made of the fate of the substances emitted to the environment (see [Section 4](#)).

Control of visible particulate plumes

- 4 Even where particulate benchmarks are already met, the aim should be to avoid visible emissions. However, because plume visibility is extremely dependent on the particle size and reflectivity, the angle of the light, and the sky background, it is accepted that, even when BAT is employed and very low emissions are being achieved, some plumes may still be visible under particular conditions.

Control of visible condensed water plumes

- 5 The need to minimise water vapour plumes should always be considered as, in addition to possible local visual amenity issues, in severe cases, plumes can cause loss of light, fogging, icing of roads, etc. High moisture content can also adversely affect plume dispersion so, where practicable, water content of the exhaust stream should be reduced. Ideally, the exhaust should be discharged at conditions of temperature and moisture content that avoid saturation under a wide range of meteorological conditions, including cold damp conditions.
- 6 The use of **primary energy** to reduce a plume simply because it is visible is not considered BAT. However, it may be appropriate to use **waste or recovered heat**, for example, heat in a gas stream prior to wet scrubbing can be used for re-heating the exhaust stream after scrubbing by means of a gas-gas heat exchanger. The use of energy for exhaust gas re-heat should be balanced against the benefits gained.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for the control of point-source emissions to air (Sheet 2 of 2)

- 7 The Operator should provide the following with the application as appropriate. If there is any doubt, the degree of detail required should be established in pre-application discussions:
 - a description of the abatement equipment for each activity;
 - the identification of the main chemical constituents of the emissions (particularly for any mixtures of VOCs) and assessment of the fate of these chemicals in the environment;
 - measures to increase the security with which the required performance is delivered;
- 8 Measures to ensure that there is adequate dispersion of the emission(s) to prevent exceedances of local ground level pollution thresholds and limit national and transboundary pollution impacts, based on the most sensitive receptor, be it human health, soil or terrestrial ecosystems.
- 9 Emergency vents and bleeders should be listed. Specific arrangements to minimise the need to use them should be described, in particular coke oven and blast furnace bleeders.

2.2.2 Point source emissions to surface water and sewer

The nature and source of the emissions to surface water or sewer expected from each activity is given in previous sections and the inventory of emissions should be confirmed in detail in the Application.

As noted before, the primary consideration should always be to prevent releases of harmful substances to the aquatic environment, whether releases are direct or via a sewage treatment works, and only where prevention is not practicable should the release be minimised or reduced to the point where the emission is incapable of causing significant harm.

A wide variety of techniques is available for the control of releases to water or sewer, and the BREF on Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector (see [Ref 1](#)) should be consulted. Section 3.3 of the BREF has details of available water treatment techniques and Section 4.3.1 contains recommendations on what might constitute BAT for a variety of treatment techniques for releases to water.

In addition to the BREF and the techniques noted below, guidance on cost-effective effluent treatment techniques can be found in [Releases to water references](#).

Waste water can arise from the process, rain-water run-off where there is the potential for contamination, from storm water, from cooling water, from treating accidental releases of raw materials, products or waste materials, and from fire-fighting - and, where not insignificant, these should all be taken into account in the Application and in the Permit.

In general, wastewater can arise from the following activities:

- run-off from raw materials and product storage areas
- treated process waters, including gas cleaning at coke oven by-products plant, blast furnaces and BOS plant; secondary spray or air mist cooling on continuous casting plant
- general purpose and utility service water
- storm water
- accidental emissions of raw materials, products or waste materials
- fire fighting

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

In addition to the various BREFs ([Ref 1](#)) and the techniques below, guidance on cost-effective effluent treatment techniques can be found in [Water efficiency references](#):

Effluent treatment

Summary of the activities

In addition to the BREF and the techniques below, guidance on cost effective, effluent treatment techniques can be found in Technical Guidance A4 and Envirowise Guides [Ref 10](#). Common techniques are listed in Table 2-7.

Table 2.7: Waste water abatement techniques

Contaminant	Abatement techniques
Suspended solids	Coagulation/flocculation Sedimentation Hydro-cyclone Flotation Filtration
Oil / grease	Chemical treatment "Mops"/"Skimmers"
pH	Neutralisation
Insoluble organics	Separators
Biodegradable organics	Aerobic treatment Anaerobic treatment
Volatile organics	Air stripping Steam stripping Distillation Activated carbon Evaporation Thermal oxidation
Metals	Chemical coagulation Ion exchange
Ammonia	Ammonia stripping
Cyanide	Oxidation Ion exchange Stripping Carbon adsorption
Nutrients (N)	Suspended-growth nitrification and denitrification variations Fixed-film nitrification and denitrification variations Ion exchange Breakpoint chlorination Natural systems
Nutrients (P)	Metal-salt addition Lime coagulation Biological phosphorus removal Biological-chemical phosphorus removal
Nutrients (N+P)	Biological removal

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Table 2.7: Waste water abatement techniques

Contaminant	Abatement techniques
Refractory organics	Carbon adsorption Ozonation Supercritical water oxidation Wet air/oxygen oxidation Chemical oxidation
Dissolved organic solids	Ion exchange Membrane separation Carbon adsorption

See BREF Sections 3.2.2.3, 4.2.2.2, 6.2.3, 7.2.2.3, 8.2.2.3 & 9.2.2.3

Indicative BAT requirements for the control of effluent treatment (Sheet 1 of 3)

General Principles

- 1 The following general principles should be applied in sequence to control emissions to water:
 - water use should be minimised and wastewater reused or recycled (see also [Section 2.4.3](#))
 - contamination risk of process or surface water should be minimised (see also [Section 2.2.5](#))
 - wherever possible, closed loop cooling systems should be used and procedures in place to ensure blow down is minimised
 - where any potentially harmful materials are used measures should be taken to prevent them entering the water circuit
- 2 Consideration should be given to the use of filtration/osmosis or other techniques which allow the effluent water to be cleaned for release or, preferably, for return to the process. Particular consideration should be given to the fate of the concentrated residues of such techniques. These can often be returned to furnaces, evaporated, solidified, sent for incineration etc. Tankering of such residues off the site as waste, simply transfers the problem to another place unless they are sent to a facility with the genuine ability to recycle the materials.
- 3 If the pollutants in the wastewater are all readily biodegradable or the effluent contains only materials which are naturally occurring in much larger quantities in the receiving water, there may be justification for filtration/osmosis or similar techniques not being considered appropriate.
- 4 Where prevention is not possible, the emissions benchmarks given in [Section 3](#), should be achieved.
- 5 Where effluent is treated off-site at a sewage treatment works the above factors still apply. In particular, it should be demonstrated:
 - the treatment provided at the sewage treatment works is as good as would be achieved if the emission were treated on-site, based on reduction of load (not concentration) of each substance to the receiving water. (The [IPPC Environmental Assessments for BAT - H1 Software tool](#) will assist in making this assessment.)
 - that action plans are appropriate to prevent direct discharge of the waste-waters in the event of sewer bypass, (via storm/emergency overflows or at intermediate sewage pumping stations) - for example, knowing when bypass is occurring, rescheduling activities such as cleaning or even shutting down when bypass is occurring.
 - that a suitable monitoring programme is in place for emissions to sewer.
- 6 There must be an understanding of the main chemical constituents of the treated effluent (including the make-up of the COD and the presence of any substances of particular concern to the aqueous environment). The fate of these chemicals in the environment should be assessed.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for the control of effluent treatment (Sheet 2 of 3)

7 As a minimum, all emissions should be controlled to avoid a breach of water quality standards (see [Section 3.2](#) and [Section 4.1](#)), but where another technique can deliver better results at reasonable cost it will be considered BAT and should be used (see [Section 1.1](#)). Unless reasonably self-evident, the EQS and BAT points should be demonstrated by calculations and/or modelling in the Application.

General Water Treatment Techniques

8 With regard to BOD the nature of the receiving water should be taken into account. However, in IPPC the prevention or reduction of BOD is also subject to BAT and further reductions 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 should also be considered. Guidance on treatment of persistent substances can be found in References, (see [Ref 10](#)).

Waste water treatment at integrated and electric arc steel plants

9 Waste water treatment at a steelworks is site specific. Generally, it should comprise the following steps:

Primary treatment

10 Primary treatment either prepares the dirty process water for recirculation or waste waters for further treatment or, in the case of surface run-off, for direct discharge from the site. They are generally physical/chemical treatments, including the following:

- Suspended solids removal:
 - settlement, with or without flocculation
 - flotation, with or without air assistance
 - hydrocyclone separation
 - removal and dewatering of scale and sludges
 - sand filtration of treated water
- Oil removal
 - physical
- Neutralisation
- Chemical precipitation
 - by pH control
 - by other means

11 And if necessary:

- Oil removal
 - chemical
 - thermal
- Oxidation
 - by ozone, hydrogen peroxide, sodium hypochlorite, chlorine or oxygen
 - by a combination of techniques, including ultra-violet radiation and catalyst systems

Secondary/tertiary treatment

12 Biological treatment using aerobic digestion is typically necessary on streams containing BOD, e.g. from coke oven by-product plants. Balancing ponds are required before biological treatment to smooth load, protecting the microbes. Reed bed technology is an alternative but the phragmite reeds require a large area and need time to adapt to high BOD load. Tertiary treatment processes are not normally required but may include:

- Activated carbon adsorption.
- Ion exchange/macrocyclic resins.
- Membrane processes.
- Electrochemical techniques, including electrodeposition.

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In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for the control of effluent treatment (Sheet 3 of 3)

Scale and sludge dewatering and disposal

- 13 Blast furnace and BOS plant slurries should normally be thickened by gravity thickening in clarifiers and then pumped to lagoons to dry out before recycling. Biological sludges require filtration or mechanical dewatering before recycling to the coke ovens, landfilling or incineration. The typical methods of dewatering sludge include combinations of the following:
- Sludge lagoons.
 - Gravity thickening.
 - Filtration by:
 - rotary vacuum filters
 - belt presses, tube presses, filter plate presses
 - other filters
 - Mechanical dewatering by centrifuging.
 - Drying
 - natural or thermal

Waste water treatment at coke making plants (BREF Section 6.2.3)

- 14 Two substantial waste water streams from a coking plant will requiring treatment: (i) excess stripped liquor from the ammonia stills and condensate from the benzole plant; and (ii) blowdown from the COG desulphurisation process. Liquor and condensate will contain ammonia, phenols, thiocyanates and traces of other organic compounds. The treatment scheme will depend on content and requirements of the receiving water; in addition to the general requirement to use BAT to reduce emissions. The liquor and condensate would normally require treatment with an activated sludge process (usually air is sufficient but oxygen is an option) or a reed bed. Activated carbon filters and/or a sand bed might be required to protect the quality of some surface waters. Tertiary cleanup is unlikely to be necessary if discharging to sewer.
- 15 The COG desulphurisation blowdown will require separate treatment as it is too concentrated for the microbes in a biological treatment plant.
- 16 Further lowering of ammonia levels can be achieved by use of nitrification/denitrification treatment. Dissolved air flotation can be used if suspended solids are high.
- 17 Mixing the excess sludge intimately with the coal feed to the coke ovens is usually considered BAT, provided heavy metal contamination from other (i.e. non-coke oven) sources is insignificant.
- 18 Note that at an integrated iron and steel works, secondary/tertiary effluent treatment for the coking plant effluent streams should be combined with that for the other processes on site where it gives environmental benefits.

2.2.3 Point source emissions to groundwater

Groundwater protection legislation

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

- i. The Permit shall not be granted at all if it would allow the *direct discharge* of a List I substance (Regulation 4(1)) - except in very limited circumstances (see Notes 1 and 2, below).

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

- ii. If the Permit allows the disposal of a List I substance or any activity that might lead to an *indirect discharge* 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. In any event, conditions to secure the 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 Environment Agency's policies on this, are outlined in the Environment Agency's document [Policy and Practice for the Protection of Groundwater](#). This outlines the concepts of vulnerability and risk and the likely acceptability from the Regulator's viewpoint of certain activities within groundwater protection zones. These are categorised as:

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; and the composition and volume of waste to be disposed of; and the rate of planned disposal.

The Environment Agency has produced a series of maps for England and Wales, which provide a guide to potential groundwater vulnerability. SEPA has produced some maps covering Scotland, and others are being developed. Updated groundwater vulnerability maps for Northern Ireland are being produced over the next 1 - 2 years, with some comment upon the vulnerability at individual sites provided, if requested. Source Protection Zones are intended to aid protection by defining annular zones around each major potable source, including springs, boreholes and wells, based on travel times.

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 (see [Appendix 3](#))

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for point source emissions to groundwater
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.

- 1 In general, there should be no permitted releases to groundwater of either a direct or indirect nature.
- 2 If there are releases to groundwater and they are to continue, the requirements of the Regulations, as summarised above, must be complied with.

2.2.4 Control of fugitive emissions to air

On coke, iron and steel processes, fugitive or diffuse emissions can be as significant as point source emissions.

Common sources of fugitive emissions are:

- primary and/or secondary collection systems overwhelmed by process upset (e.g. cast house fume abatement overloaded by twin tapping or blowdown; BOS primary and secondary fume collection in slopping situations)
- volatile leakage through ascension pipe, door and lid seals and brickwork on coke ovens
- open vessels (e.g. coke oven by-product plant)
- storage areas (e.g. coal and ore stockpiles, lagoons etc.)
- the loading and unloading of ships, trains and lorries
- transferring material from one vessel to another (e.g. furnace, ladle, silos)
- conveyor systems
- pipework and ductwork systems (e.g. pumps, valves, flanges, catchpots, drains, inspection hatches etc. on by-product plants)
- potential for bypass of abatement equipment (e.g. coke side particulate collection hoods)
- accidental loss of containment from failed plant and equipment

Some significant specific sources are given below.

Process	Emission	Process	Emission
Coal, ore stock yards & roads	Particulates	Blast furnace cast house	Iron oxide fume
Sinter plant hot screens		Iron plating	
Sinter coolers		BOS plant building	
Raw material conveyors		Metal recovery	
Coke oven:		Cooling BF slag	H ₂ S & SO ₂
- Batteries	Volatile fume	By-product plant	BTX & ammonia
- Charging	Coal dust		
- Pushing	Coke dust		

As part of the Application the Operator should identify and, where possible quantify, significant fugitive emissions to air from all the specific relevant sources listed above, estimating the proportion of total emissions that are attributable to fugitive releases for each substance. Where there are opportunities for reductions, the Permit may require the updated inventory of fugitive emissions to be submitted.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for fugitive emissions to air

- 1 **Dust** - The following general techniques should be employed where appropriate:
 - Covering of skips and vessels
 - Avoidance of outdoor or uncovered stockpiles (where possible)
 - Where dust creation is unavoidable, use of sprays, binders, stockpile management techniques, windbreaks and so on
 - Regular wheel and road cleaning (avoiding transfer of pollution to water and wind blow)
 - Closed conveyors, pneumatic or screw conveying (noting the higher energy needs), minimising drops. Filters on the conveyors to clean the transport air prior to release
 - Regular housekeeping
 - Enclosed silos (for storage of bulk powder materials) vented to fabric filters. The recycling of collected material should be considered under Section 2.6.
 - Enclosed containers or sealed bags used for smaller quantities of fine materials

- 2 **VOCs**
 - When transferring volatile liquids, the following techniques should be employed – subsurface filling via (anti-syphon) filling pipes extended to the bottom of the container, the use of vapour balance lines that transfer the vapour from the container being filled to the one being emptied, or an enclosed system with extraction to suitable abatement plant.
 - Vent systems should be chosen to minimise breathing emissions (for example pressure/ vacuum valves) and, where relevant, should be fitted with knock-out pots and appropriate abatement equipment.
 - Maintenance of bulk storage temperatures as low as practicable, taking into account changes due to solar heating etc.
 - The following techniques should be used (together or in any combination) to reduce losses from storage tanks at atmospheric pressure:
 - Tank paint with low solar absorbency
 - Temperature control
 - Tank insulation
 - Inventory management
 - Floating roof tanks
 - Bladder roof tanks
 - Pressure/vacuum valves, where tanks are designed to withstand pressure fluctuations
 - Specific release treatment (such as adsorption condensation)

- 3 For Information on Odour, see [Section 2.2.6](#).

2.2.5 Fugitive emissions to surface water, sewer and groundwater

As part of the Application, the Operator should identify and, where possible, quantify significant fugitive emissions to water, sewer or ground from all relevant sources, and estimate the proportion of total emissions that are attributable to fugitive releases for each of the main substances releases.

Some common examples of sources of fugitive releases to waters and their preventive measures are given in the BAT box below.

See BREF Section 6.2.5 & 9.2.2.4

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for fugitive emissions to water (Sheet 1 of 2)

1 For **subsurface structures**:

- establish and record the routing of all installation drains and subsurface pipework;
- identify all sub-surface sumps and storage vessels;
- engineer systems to minimise leakages from pipes and ensure swift detection if they do occur, particularly where hazardous (ie. Groundwater-listed) substances are involved;
- provide secondary containment and/or leakage detection for sub-surface pipework, sumps and storage vessels;
- establish an inspection and maintenance programme for all subsurface structures, eg. pressure tests, leak tests, material thickness checks or CCTV

All sumps should:

- be impermeable and resistant to stored materials;
- be subject to regular visual inspection and any contents pumped out or otherwise removed after checking for contamination;
- where not frequently inspected, be fitted with a high level probe and alarm, as appropriate;
- be subject to programmed engineering inspection (normally visual, but extending to water testing where structural integrity is in doubt).

2 For **surfacing**:

- design appropriate surfacing and containment or drainage facilities for all operational areas, taking into consideration collection capacities, surface thicknesses, strength/reinforcement; falls, materials of construction, permeability, resistance to chemical attack, and inspection and maintenance procedures;
- have an inspection and maintenance programme for impervious surfaces and containment facilities;
- unless the risk is negligible, have improvement plans in place where operational areas have not been equipped with:
 - an impervious surface
 - spill containment kerbs
 - sealed construction joints
 - connection to a sealed drainage system

3 All **above-ground tanks** containing liquids whose spillage could be harmful to the environment should be banded. For further information on bund sizing and design, see the [Releases to water references](#). Bunds should:

- be impermeable and resistant to the stored materials;
- have no outlet (that is, no drains or taps) and drain to a blind collection point;
- have pipework routed within banded areas with no penetration of contained surfaces;
- be designed to catch leaks from tanks or fittings;
- have a capacity greater than 110 percent of the largest tank or 25 percent of the total tankage, whichever is the larger;
- 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;
- where possible, have tanker connection points within the bund, otherwise provide adequate containment;
- be subject to programmed engineering inspection (normally visual, but extending to water testing where structural integrity is in doubt).

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for fugitive emissions to water (Sheet 2 of 2)

- 4 **Storage areas for IBCs, drums, bags, etc**, should be designed and operated to minimise the risk of releases to the environment. In particular:
- Storage areas should be located away from watercourses and sensitive boundaries, (eg. those with public access) and should be protected against vandalism.
 - Storage areas should have appropriate signs and notices and be clearly marked-out, and all containers and packages should be clearly labelled.
 - Where spillage of any stored substance could be harmful to the environment, the area should be appropriately kerbed or bunded.
 - The maximum storage capacity of storage areas should be stated and not exceeded, and the maximum storage period for containers should be specified and adhered to.
 - Appropriate storage facilities should be provided for substances with special requirements (eg. flammable, sensitive to heat or light) and formal arrangements should be in hand to keep separate packages containing incompatible substances (both “pure” and waste).
 - Containers should be stored with lids, caps and valves secured and in place - and this also applies to emptied containers.
 - All stocks of containers, drums and small packages should be regularly inspected (at least weekly).
 - Procedures should be in place to deal with damaged or leaking containers.

2.2.6 Odour

In an Application for a Permit, the Operator should supply a level of detail in keeping with the risk of causing odour-related annoyance at sensitive receptors. Where an installation poses no risk of odour-related environmental impact because the activities are inherently non-odorous, a simple justification should normally suffice.

However, where odour could be a problem, the Operator should assess the situation carefully and supply the information as indicated below to demonstrate that BAT is being used:

- Information relating to sensitive receptors, in particular the type of receptor, location relative to the odour sources and an assessment of the impact of odorous emissions on those receptors. (This should normally be available before a Permit is issued, but where very detailed information has to be obtained the Operator may be able to secure an agreement to supply it as part of an Improvement Programme.)
- An overview of any complaints received, what they relate to (source/operation) and remedial action taken.
- The types and source of odorous substances used or generated, intentional and fugitive (unintentional) release points and monitoring undertaken.
- Actions taken to prevent or minimise
 - A description of the actions taken to prevent and/or minimise odour annoyance for each odour source.
 - A demonstration that the indicative BAT requirements are being complied with.
 - Identification of any circumstances or conditions which might compromise the ability to prevent or minimise odour annoyance, and a description of the actions that will be taken to minimise the impact.

There may be a requirement placed upon the Operator to provide some or all of this information in the form of an odour management statement.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions control	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

The use of appropriate sections of H4 Horizontal Guidance for Odour - Part 1 (Regulation and Permitting) and Part 2 (Assessment and Control) is advised.

In this sector, odour can arise from the following sources:

- VOC from coke oven batteries
- ammonia and BTX from byproducts plants (processes and storage)
- SO₂ and H₂S from air and water cooled blast furnace slag
- VOC from coke ovens and biological effluent treatment plants

Indicative BAT requirements for odour control

- 1 The requirements for odour control will be installation-specific and depend on the sources and nature of the potential odour. In general:
- 2 Where odour can be contained, for example within buildings, the Operator should maintain the containment and manage the operations to prevent its release at all times.
- 3 Where odour releases are expected to be acknowledged in the Permit, (i.e. contained and treated prior to discharge or discharged for atmospheric dispersion):
 - *For existing installations*, the releases should be modelled to demonstrate the odour impact at sensitive receptors. The target should be to minimise the frequency of exposure to ground level concentrations that are likely to cause annoyance.
 - *For new installations, or for significant changes*, the releases should be modelled and it is expected that the Operator will achieve the highest level of protection that is achievable with BAT from the outset.
 - Where there is no history of odour problems then modelling may not be required although it should be remembered that there can still be an underlying level of annoyance without complaints being made.
 - Where, despite all reasonable steps in the design of the plant, extreme weather or other incidents are liable, in the view of the Regulator, to increase the odour impact at receptors, the Operator should take appropriate and timely action, as agreed with the Regulator, to prevent further annoyance (these agreed actions will be defined either in the Permit or in an odour management statement).
- 4 Where odour generating activities take place in the open, (or potentially odorous materials are stored outside) a high level of management control and use of best practice will be expected.
- 5 Where an installation releases odours but has a low environmental impact by virtue of its remoteness from sensitive receptors, it is expected that the Operator will work towards achieving the standards described in this Note, but the timescales allowed to achieve this might be adjusted according to the perceived risk.

Point source emissions
- 6 If a point source can be identified which might have off-site odour impact (e.g. BTX from By-Products plants), a simple modelling exercise should be undertaken to demonstrate that the risk of off-site areas exceeding the odour threshold is remote. Details of this assessment should be included in the application.

Fugitive emissions
- 7 The potential for fugitive odorous emissions should be identified, e.g. slag pits and ETP. Many of the appropriate measures are the same as in [Section 2.2.4](#) for the control of general fugitive emissions to air.
- 8 Further guidance on control techniques is which also gives information on assessment and on dispersion design criteria.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.3 Management

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 formal environmental management systems (EMSs). An Operator with such a system will not only find it easier to meet the BAT requirements for management of the installation but also many of the technical/regulatory requirements listed in other Sections of this Guidance.

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The Regulators recommend either certification to the ISO 14001 standard or registration under EMAS (EC Eco Management and Audit Scheme) (OJ L114, 24/04/01). Both certification and registration provide independent verification that the EMS conforms to an auditable standard. EMAS now incorporates ISO 14001 as the specification for the EMS element, and the Regulators consider that overall EMAS has a number of other benefits over ISO14001 - including a greater focus on environmental performance, a greater emphasis on legal compliance, and a public environmental statement. For further details about ISO 14001 and EMAS contact British Standards Institute (BSI) or the Institute of Environmental Management and Assessment (IEMA), respectively.

Whilst an effective EMS will help the Operator to maintain compliance with specific regulatory requirements and manage all significant environmental impacts, this section of the Guidance identifies only those EMS requirements that are not specifically covered elsewhere in the document. This Section should not, therefore, be taken to describe all of the elements of an effective environmental management system. The requirements below are considered to be BAT for IPPC, but they are the same techniques required by a formal EMS and so should be capable of delivering wide environmental benefits.

Indicative BAT requirements for management techniques (Sheet 1 of 3)

Operations and maintenance

- 1 Effective operational and maintenance systems should be employed on all aspects of the process whose failure could impact on the environment, in particular there should be:
 - documented procedures to control operations that may have an adverse impact on the environment
 - a defined procedure for identifying, reviewing and prioritising items of plant for which a preventative maintenance regime is appropriate
 - documented procedures for monitoring emissions or impacts
 - a preventative maintenance programme covering all plant, whose failure could lead to impact on the environment, including regular inspection of major 'non productive' items such as tanks, pipework, retaining walls, bunds ducts and filters
- 2 The maintenance system should include auditing of performance against requirements arising from the above and reporting the result of audits to top management.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for management techniques (Sheet 2 of 3)

Competence and training

- 3 Training systems, covering the following items, should be in place for all relevant staff which cover
 - 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
 - awareness of the need to report deviation from the Permit
 - prevention of accidental emissions and action to be taken when accidental emissions occur
- 4 The skills and competencies necessary for key posts should be documented and records of training needs and training received for these post maintained.
- 5 The key posts should include contractors and those purchasing equipment and materials;
- 6 The potential environmental risks posed by the work of contractors should be assessed and instructions provided to contractors about protecting the environment while working on site.
- 7 Where industry standards or codes of practice for training exist (e.g. WAMITAB) they should be complied with.

Accidents/incidents/non-conformance

- 8 There should be an accident plan as described in [Section 2.8](#) which:
 - identifies the likelihood and consequence of accidents
 - identifies actions to prevent accidents and mitigate any consequences
- 9 There should be written procedures for handling, investigating, communicating and reporting actual or potential non-compliance with operating procedures or emission limits.
- 10 There should be written procedures for handling, investigating, communicating and reporting environmental complaints and implementation of appropriate actions.
- 11 There should be written procedures for investigating incidents, (and near misses) including identifying suitable corrective action and following up

Organisation

The following are indicators of good performance which may impact on the Regulator's resources, but not all will necessarily be insisted upon as Permit conditions:

- 12 The company should adopt an environmental policy and programme which:
 - includes a commitment to continual improvement and prevention of pollution;
 - includes a commitment to comply with relevant legislation and other requirements to which the organisation subscribes; and
 - identifies, sets, monitors and reviews environmental objectives and key performance indicators independently of the Permit.
- 13 The company should have demonstrable procedures (eg. written instructions) which incorporate environmental considerations into the following areas:
 - the control of process and engineering change on the installation;
 - design, construction and review of new facilities and other capital projects (including provision for their decommissioning);
 - capital approval; and
 - purchasing policy.

Introduction		Techniques for pollution control			Emissions			Impact			
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Indicative BAT requirements for management techniques (Sheet 3 of 3)

- 14 The company should conduct audits, at least annually, to check that all activities are being carried out in conformity with the above requirements. Preferably, these should be independent.
- 15 The company should report annually on environmental performance, objectives and targets, and future planned improvements. Preferably, these should be published environmental statements.
- 16 The company should operate a formal Environmental Management System. Preferably, this should be a registered or certified EMAS/ISO 14001 system (issued and audited by an accredited certification body).
- 17 The company should have a clear and logical system for keeping records of, amongst others:
 - policies
 - roles and responsibilities
 - targets
 - procedures
 - results of audits
 - results of reviews

Introduction			Techniques for pollution control			Emissions			Impact		
In-process controls	Emissions controls	Management	Raw Materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.4 Raw Materials

This section covers the use of raw materials and water, and the techniques for both minimising their use and minimising their impact by selection. (Energy and fuels are covered under [Section 2.7](#), Energy).

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

- reduce the usage of all raw materials and intermediates ([Section 2.4.2](#))
- substitute less harmful materials, or those which can be more readily abated and when abated lead to substances that are more readily dealt with ([Section 2.4.1](#))
- understand the fate of by-products and contaminants and their environmental impact ([Section 2.4.2](#))

2.4.1 Raw materials selection

This section looks at the selection and substitution of raw materials and the following section, [Section 2.4.2](#), describes the techniques to minimise their use.

The process of selecting raw materials can present an opportunity to control emissions at source so, in this regard, the range of possible raw material options should be carefully examined.

An Application for a Permit should contain a list of the materials in use which have potential for significant environmental impact, together with the following associated information:

- the chemical composition of the materials, where relevant;
- the quantities used;
- the fate of the material in the installation (i.e. approximate percentages to each environmental medium and to the products);
- the environmental impact potential, where known (e.g. degradability, bioaccumulation potential, toxicity to relevant species);
- any reasonably practicable alternative raw materials that may have a lower environmental impact (including, but not limited to, any alternatives described in the BAT requirements below) on the substitution principle;
- and justification for the continued use of any substance for which there is a less hazardous alternative (e.g. on the basis of impact on product quality) to show that the proposed raw materials are therefore BAT.

In general, steel scrap should be free from significant contamination with plastics, oil or halogenated materials such as PCBs. However, it may be appropriate, in certain carefully assessed circumstances, to recycle certain materials containing plastics or other contaminants to furnaces. The assessment would need to consider emissions, effects and BPEO; and comply with appropriate legislation. Compliance may be achieved through procedural safeguards in the Permit or require a variation of the Permit.

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Indicative BAT requirements for raw materials selection

- 1 The Operator should maintain a list of raw materials and their properties as noted above.
- 2 The Operator should have procedures for the regular review of new developments in raw materials and for the implementation of any suitable ones with an improved environmental profile.
- 3 The Operator should have quality-assurance procedures for controlling the impurity content of raw materials.
- 4 The Operator should complete any longer-term studies needed into the less polluting options and should make any material substitutions identified.
- 5 The raw material selection techniques in [Table 2.8](#) below should be applied where appropriate

Table 2.8: Raw material selection techniques

Raw material	Selection technique
Water	<ul style="list-style-type: none"> • identify most sustainable source (consider recycle sources)
Iron ores	<ul style="list-style-type: none"> • sulphur content should be minimised
Limestones and dolomites	
Anthracites	<ul style="list-style-type: none"> • use in sinter plants should be justified as it may increase release of aromatic hydrocarbons
Coals for coking blends	<ul style="list-style-type: none"> • the lowest sulphur content coals and cokes should be used provided they meet process requirements.
Coke	
Fuel oils	<ul style="list-style-type: none"> • Sulphur content should be minimised. See Section 3.4

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

The options for waste recovery and recycling are covered in [Section 2.6](#). Waste avoidance/minimisation, and the use of clean technologies, is a theme which runs throughout [Section 2.1](#) and [Section 2.2](#). This section deals with the systematic approach to look for other opportunities.

Waste minimisation can be defined simply as: “a systematic approach to the reduction of waste at source, by understanding and changing processes and activities to prevent and reduce waste”.

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

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

Key operational features of waste minimisation will be:

- the ongoing identification and implementation of waste prevention opportunities
- the active participation and commitment of staff at all levels including, for example staff suggestion schemes

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- monitoring of materials' usage and reporting against key performance measures

For the primary inputs to activities which are themselves waste activities, eg. incineration, the requirements of this section may have been met "upstream" of the installation. However, there may still be arisings that are relevant.

See the [Waste minimisation support references](#) for detailed information, guides and case studies on waste minimisation techniques.

Indicative BAT requirements for waste minimisation audits Identify the raw and auxiliary materials, other substances and water that they propose to use.

1 The Operator should carry out a waste minimisation audit at least every 4 years. If an audit has not been carried out in the 2 years prior to submission of the Application for a Permit and the details made known at the time of that application, then the first audit shall take place within 2 years of the issue of the Permit. The methodology used and an action plan for reducing the use of raw materials should be submitted to the Regulator within 2 months of completion of the audit. 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

- process mapping
- materials mass balance
- action plan

The use and fate of raw materials and other materials, including by-products, solvents and other support materials, such as fuels, catalysts and abatement agents, should be mapped onto a process flow diagram (see the [Waste minimisation support references](#)). This should be achieved by using data from the raw materials inventory and other company data as appropriate. Data should be incorporated for each principal stage of the operation in order to construct a mass balance for the installation.

- Using this information, opportunities for improved efficiency, changes in process and waste reduction should be generated and assessed. An action plan should then be prepared for implementing improvements to a timescale approved by the Regulator.
- Gases produced during production of coke, iron and steel should be quantified and opportunities for use considered, as part of an integrated fuel strategy minimising the use of imported fuels, especially fuel oil, see Section 2.7. (BREF Section 3.2.2.2)
- Water minimisation is covered in Section 2.4.3.
- Recognising that almost all integrated works waste goes to an on-site landfill and the streams do not usually vary significantly, it is permissible to analyse routine waste streams destined for on-site disposal on an annual basis - provided arrangements are fully described in the application and meet the satisfaction of the Regulator.
- Efforts should be made to reclaim raw materials from waste prior to disposal to land and, where feasible, the recovered materials should be recycled or utilised as secondary by-products, in order to minimise the quantities landfilled. Where practicable scale, dusts and sludges recovered from the steel making processes should be re-used in the process (or sold), provided this does not adversely affect the operation of the process plant, jeopardise product quality or create environmental risks.

Introduction			Techniques for pollution control			Emissions			Impact		
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Indicative BAT requirements for waste minimisation audits
Identify the raw and auxiliary materials, other substances and water that they propose to use.

- 7 **Table 2.9** summarises the common recycle and disposal routes for slags, dusts, sludges and scales from typical integrated and EAF steel works sites. Whether recycling is possible at a given site will depend on the particular plant configuration, raw materials, product qualities and methods of operation. Table 2-9 indicates where internal recycling or sale as a by-product can often be achieved, subject to an appropriate combination of factors and suitable location of the steel works relative to the potential markets for such materials.
- 8 In the case of leaded steel manufacture, lead bearing dust should be collected in labelled containers, sealed and then sent for specialist recovery. Where it is clearly demonstrated that this is not possible then the dust should be disposed of to land or other authorised disposal route by a licensed waste disposal company.

Table 2.9: Routine for recycling or disposal of slags, dust, sludges and scales

Process plant source	Recycle and disposal routes
Raw material bag filters –coal –iron ore	Recycle to: coal blend sinter plant
Coke fines (breeze)	Recycle to coal blend and sinter plant
Sinter plant primary and secondary collection	
–coarse dusts	Recycle to sinter plant; or
–fine dusts	Dispose of to landfill if high alkali or heavy metal content
Blast furnace	
–cyclone grit	Recycle cyclone and hydrocyclone material to sinter plant; or
–gas cleaning sludges	briquette and recycle to blast furnace
–ironmaking slag	Sale for cement or construction purposes
Casthouse fume dust	Recycle to sinter plant
Desulphurisation –collected dust	Not suitable for recycling – dispose of to landfill unless other application identified
–desulphurisation slag	Not suitable for recycling – dispose of to landfill unless other application identified
BOS	
–primary drop-out grit	Briquette (WOBS) and recycle to BOS or sinter plant
–primary sludges	Briquette and recycle to BOS or sinter plant
–secondary and fugitive collected dusts	Subject to heavy metal limits, briquette and recycle to BOS. Otherwise landfill
–steel making slag	Small proportion recyclable to BF or sinter plant (after Fe removed), to recover free lime, manganese and combined iron. Maximise potential sale of material (cement and construction). Dispose of remainder to landfill
EAF	
–slag	Sold as a roadstone after recovery of Fe for recycling to EAF
–EAF baghouse dust	Potentially charge to the EAF to minimise waste prior to landfilling and, if viable, process or sell zinc enriched dust for non-ferrous metal recovery

Introduction			Techniques for pollution control			Emissions			Impact		
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Table 2.9: Routine for recycling or disposal of slags, dust, sludges and scales

Process plant source	Recycle and disposal routes
Continuous casting:	
–scrap	Recycle to BOS/EAF
–scale	Recycle to sinter plant/BF/BOS/EAF or sell to cement industry
–sludge	Recycle as scale if possible; otherwise dispose of to landfill
Rolling mills	
–scrap	Recycle to BOS/EAF
–scale	Recycle to sinter plant/BF/BOS/EAF or sell to cement industry
–sludge	Recycle as for scale if possible; otherwise dispose of to landfill until recycling is feasible
Finishing processes	
–pickling sludge	Seek opportunities to recycle; otherwise landfill
–acid recovery	Recycle recovered acid and dispose of treated effluent. Sell iron oxide recovered from roasting process if possible
–other finishing processes	Seek opportunities to recycle wastes arising at galvanising, tinning and coating lines (Note: not Part A1 processes)
Waste refractories	Seek cost-effective opportunities to recover material for re-use or process to recycle; otherwise dispose of to landfill

2.4.3 Water use

Reasons for reducing water use

Water use should be minimised as part of BAT for the reduction of emissions to water and it should also be commensurate with the prudent use of water as a natural resource.

Reducing water use is normally a valid environmental (and economic) aim in itself, but any water passing through an industrial process is generally degraded so there will usually be an increase in pollutant load. The benefits to be gained from reducing water input include:

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

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

Advice on cost-effective measures for minimising water can be found in the [Water efficiency references](#).

Benchmarks are based on specific water consumption per unit of product. The consumption of the activities should be compared against:

- integrated works: 5 m³/t steel
- EAF works: 3 m³/t steel

Introduction			Techniques for pollution control			Emissions			Impact		
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- merchant coking works: 0.3 m³/t
- similar sites in the operating group (including overseas) and national benchmarks

Indicative BAT requirements for minimisation of water use (Sheet 1 of 2)
Identify the raw and auxiliary materials, other substances and water that they propose to use.

- 1 The Operator should carry out a regular review of water use (water efficiency audit) at least every 4 years. If an audit has not been carried out in the 2 years prior to submission of the application and the details made known at the time of the application, then the first audit should take place within 2 years of the issue of the Permit.
 - Flow diagrams and water mass balances for the activities should be produced.
 - Water-efficiency objectives should be established, with constraints on reducing water use beyond a certain level being identified (which usually will be usually installation-specific).
 - Water pinch techniques should be used in the more complex situations such as chemical plant, to identify the opportunities for maximising reuse and minimising use of water (see the [Water efficiency references](#)).

Within 2 months of completion of the audit, the methodology used should be submitted to the Regulator, together with proposals for a time-tabled plan for implementing water reduction improvements for approval by the Regulator.
- 2 The following general principles should be applied in sequence to reduce emissions to water:
 - Water-efficient techniques should be used at source where possible
 - Water should be recycled within the process from which it issues, by treating it first if necessary. Where this is not practicable, it should be recycled to another part of the process that has a lower water-quality requirement
 - In particular, if uncontaminated roof and surface water cannot be used in the process, it should be kept separate from other discharge streams, at least until after the contaminated streams have been treated in an effluent treatment system and been subject to final monitoring.
- 3 Measures should be in place to minimise the risk of contamination of surface waters or ground-water by fugitive releases of liquids or solids (see [Section 2.2.5](#)).
- 4 The water-quality requirements associated with each use should be established, and the scope for substituting water from recycled sources identified and input into the improvement plan.

Less contaminated water streams, such as cooling waters, should be kept separate from more contaminated streams where there is scope for reuse - though possibly after some form of treatment.

Most wastewater streams will however need some form of treatment (see [Section 2.2.2](#) for techniques) but for many applications, the best conventional effluent treatment can produce a water that is usable in the process directly or when mixed with fresh water. Though treated effluent quality can vary, it can often be recycled selectively - used when the quality is adequate, discharged when the quality falls below that which the system can tolerate.
- 5 In particular, the cost of membrane technology continues to reduce, and they can be applied to individual process streams or to the final effluent from the effluent treatment plant, as appropriate. In some applications in some Sectors, they can supplement (or possibly completely replace) the ETP plant so that most water is recyclable and there is a greatly reduced effluent volume. Where the remaining, possibly concentrated, effluent stream is sufficiently small - and particularly where waste heat is available - further treatment by evaporation can lead to zero aqueous effluent. Where appropriate, the Operator should assess the costs and benefits of using membrane techniques to minimise water usage and effluent discharge.

Introduction			Techniques for pollution control			Emissions			Impact		
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Indicative BAT requirements for minimisation of water use (Sheet 2 of 2)
Identify the raw and auxiliary materials, other substances and water that they propose to use.

- 6 Water usage for cleaning and washing down should be minimised by:
 - vacuuming, scraping or mopping in preference to hosing down;
 - reusing wash water (or recycled water) where practicable;
 - using trigger controls on all hoses, hand lances and washing equipment.
- 7 Fresh water consumption should be directly measured and recorded regularly at every significant usage point - ideally on a daily basis.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Handling of recycled and waste	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.5 Handling of recycled and waste materials

As the response to the requirement for an emissions inventory in the Application for a Permit, the nature and source of the waste from each activity should be listed in detail - though where there are a very large number of relatively small streams, some aggregation of similar and relatively insignificant waste streams may be appropriate.

Recycled materials includes dusts, scale and sludges recovered from operations at the installation (many of these are commonly termed “reverts”) and returned to operations at the installation. Waste materials are solid and liquid streams discarded and sent for recovery (e.g. metal recovery from slag), disposal, incineration or landfill (including on-site facilities); and any materials designated as waste under specific legislation. In each case, materials from associated processes need to be considered in the Application, (e.g. boiler plant), but available relevant BREF and sector guidance should be consulted.

Indicative BAT requirements for recycle and waste handling

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

- 1 A system should be in place and maintained which records the quantity, nature and origin of any waste that is disposed of or recovered - and also, where relevant, the destination, frequency of collection, mode of transport and treatment method for those wastes.
- 2 Wastes should be segregated wherever practicable, and the disposal routes identified. Disposal should be as near to the point of generation as is practicable.
- 3 Records should be maintained of any waste sent off-site (Duty of Care).
- 4 Appropriate steps should be taken to prevent all emissions from waste storage and handling (e.g. liquid or solid spillage, dust or VOC emission, and odour) (see [Section 2.2.4](#), [Section 2.2.5](#) and [Section 2.2.6](#)).
- 5 Blast furnace slurry lagoons and storage areas for sludges and other recycled material should be arranged to avoid risk to controlled waters and sensitive boundaries, e.g. adjacent to areas of public use and protected against vandalism. Lagoons should:
 - be sized to provide adequate treatment for all expected flows
 - be designed to facilitate efficient maintenance and desludging
 - be equipped with outlet control valves to contain any uncontrolled event
 - be equipped with continuous monitoring and telemetry to facilitate isolation if necessary to protect the environment
 - have back-up lagoon capacity where appropriate to facilitate continuation of effluent treatment during maintenance operations
- 6 Note: Lagoons not dredged of accumulated solids at least annually may require a waste management licence.
- 7 Storage areas for recycled materials, by-products and wastes should be clearly marked (except slags) and signed and any containers should be clearly labelled.
- 8 The maximum storage capacity of storage areas for recycled materials, by-products and wastes should be stated and not exceeded (except bulk storage of slags). The maximum storage period for containers should be specified.

Introduction			Techniques for pollution control			Emissions			Impact		
In-process controls	Emissions controls	Management	Raw materials	Handling of recycled and waste	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for recycle and waste handling

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

- 9 Appropriate storage facilities should be provided for special requirements such as for substances that are flammable, and incompatible by-product and waste types should be kept separate.
- 10 Containers should be stored with lids, caps and valves secured and in place. This also applies to emptied containers.
- 11 Storage areas, containers, drums etc. should be regularly inspected.
- 12 Procedures should be in place to deal with damaged or leaking containers.
- 13 All appropriate steps to prevent emissions (e.g. liquids, dust, VOCs and odour) from storage or handling should be taken (see Sections 2.2.4, 2.2.5 and 2.2.6).
- 14 See Section 2.1.10 for specific requirements on slag handling.

Introduction		Techniques for pollution control			Emissions			Impact			
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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 in question should be operated in such a way that “waste production is avoided in accordance with Council Directive 75/442/EEC on waste; and where waste is produced it is recovered, or where this is technically or economically impossible it is disposed of, while avoiding or reducing the impact on the environment”. The objectives of the National Waste Strategies should also be considered.

Waste avoidance (minimisation) at source is addressed in detail in [Section 2.1](#) and related issues are addressed in the sections on abatement techniques (see [Section 2.2](#)). The specific requirement for a waste minimisation audit is noted in [Section 2.4.2](#).

To meet these requirements, Operators should provide the Regulator with the information requested in point 2 below.

See *BREF Sections 3.2.2.2, 4.2.2.3, 7.2.2.2, 8.2.2.2, 9.2.2.2*

Indicative BAT requirements for waste recovery or disposal

Describe how each waste stream is proposed 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.

- 1 Waste should be recovered, unless it is technically or economically impractical to do so.
- 2 Where waste must be disposed of, the Operator should provide a detailed assessment identifying the best environmental options for waste disposal - unless the Regulator agrees that this is unnecessary. For existing disposal activities, this assessment may be carried out as an improvement condition to a timescale to be approved by the Regulator.
- 3 Where appropriate, (e.g. disposal of pickling acids), operations should meet the requirements of the Hazardous Waste Directive 91/689/EEC, as implemented under the UK Special Waste Regulations 1996 (SI 1996 No 972). There are storage and record keeping requirements for Special Waste.
- 4 Unless agreed with the Regulator to be inappropriate, the Operator should provide a detailed assessment identifying the best practicable environmental options for recycling and waste disposal. For existing activities, this may be carried out as an improvement condition to a timescale to be approved by the Regulator.
- 5 Some routes for recycling or disposal of common wastes are given in [Table 2.9](#). A substantial proportion of material is currently landfilled, so new techniques for recovery/recycle and new markets are being developed. Applicants should describe ongoing activities aimed at increasing recycling and finding new markets, in particular for BOS slags and slurry, iron dusts, refractories and millscale (associated activity).
- 6 See [Section 2.1.10](#) for further specific requirements on slag handling.
- 7 In the case of leaded steel manufacture, all dust should be collected in labelled containers, sealed and then disposed to landfill or other authorised disposal route by a licensed waste disposal company.

Introduction			Techniques for pollution control			Emissions			Impact		
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2.7 Energy

Operators participating in a CCL Agreement are not expected to implement capital projects for energy efficiency (alone) under a PPC Permit; provided they stay in the Agreement

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 Section 2.7.1 and Section 2.7.2 below and is a participant to a Climate Change Agreement (CCA) or a Direct Participant Agreement (DPA) within the Emissions Trading Scheme.

or

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

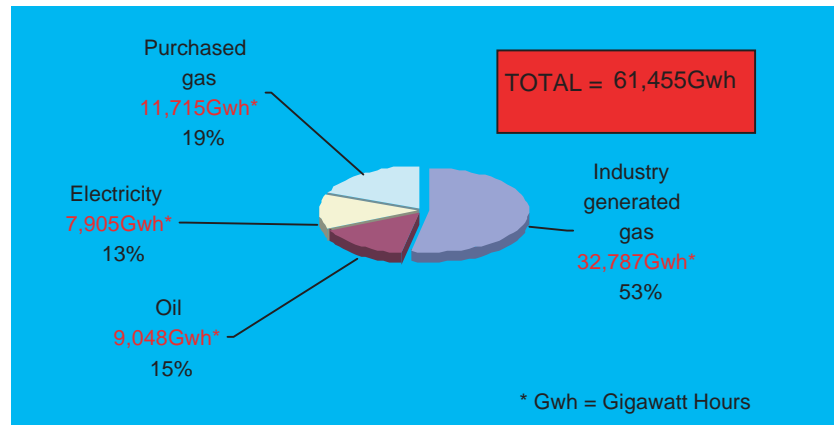
Note that even where a Climate Change Agreement or Direct Participant Agreement is in place, this does not preclude the consideration of energy efficiency (including those identified in Section 2.7.3) as part of an integrated assessment of BAT where they impact on other emissions, e.g. where:

- 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 Combined Heat and Power (CHP)
- the most energy-intensive abatement leads to the greatest reduction in other emissions

Further guidance is given in the guidance note [H2 Energy efficiency for IPPC](#).

Figure 2-10 - Energy Used in UK Steel Production (1998)
(UK Steel Association)

Figure 2.10: Energy consumption in iron and steel making



Introduction		Techniques for pollution control			Emissions			Impact			
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2.7.1 Basic energy requirements (1)

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

Indicative BAT requirements for basic energy requirements (1):

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

- 1 The Operator should provide the energy consumption information, shown in the table below, 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 Operator should provide details of such factors. Where energy is exported from the installation, the Operator should also provide this information. All this information should be submitted in the application (in England and Wales the H1 software tool should be used to produce this information). The Operator should also provide energy flow information (such as “Sankey” diagrams or energy balances) showing how the energy is used throughout the process.
- 2 The Operator should provide the following Specific Energy Consumption (SEC) information. Define and calculate the SEC 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. Provide a comparison of SEC against any relevant benchmarks available for the sector. (See Energy Efficiency Guidance)
- 3 The Operator should provide associated environmental emissions. This is dealt with in the Operator’s response to the emissions inventory using the H1 software tool.

Table 2.10: Example breakdown of delivered and primary energy consumption

Energy source	Energy consumption		
	Delivered, MWh	Primary, MWh	% of total
Electricity*			
Gas			
Coking coal			
Other coal			
Oxygen (m3 per annum for EAF only)			
Oil			
Other (Operator to specify)			

* specify source.

Introduction		Techniques for pollution control			Emissions			Impact			
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2.7.2 Basic energy requirements (2)

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

Indicative BAT requirements for basic energy requirements (2)

Describe the proposed measures for improvement of energy efficiency.

- 1 **Operating, maintenance and housekeeping measures** should be in place in the following areas, where relevant: (Indicative checklists of appropriate measures are provided in Appendix 2 of the guidance note [H2 Energy efficiency for IPPC](#).)
 - 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 operation and maintenance, e.g. 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 (e.g. by fitting simple control systems such as timers and sensors).
- 3 **Energy-efficient building services** should be in place to deliver the requirements of the Building Services section of the guidance note [H2 Energy efficiency for IPPC](#). For energy-intensive industries these issues may be of minor impact and should not distract effort from the major energy issues, but 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 2.3](#) 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 DPA; 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.
- 6 An example format of the energy efficiency plan is shown in [Table 2.11](#).

Introduction			Techniques for pollution control			Emissions			Impact		
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Table 2.11: Example format for energy efficiency plan

ALL APPLICANTS			ONLY APPLICANTS WITHOUT CCA		
Energy efficiency measure	CO ₂ savings (tonnes)		Equivalent Annual Cost (EAC) £k	EAC/CO ₂ saved £/tonne	Date for implementation
	Annual	lifetime			

The Energy Efficiency Guidance Note provides an appraisal methodology. If Operators use other appraisal methodologies they should state the method in the Application, 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 or DPA is in place the Regulator will only enforce implementation of those measures in categories 1-3 above.

2.7.3 Further energy-efficiency requirements

Indicative BAT requirements for further energy-efficiency requirements (Sheet 1 of 3) Climate Change Agreement for Trading Agreement.

1 The following techniques should be implemented where they are judged to be BAT based on a cost/benefit appraisal according to the methodology provided in Appendix 4 of the Guidance Note [H2 Energy efficiency for IPPC](#).

- use of heat recovered from different parts of the installation
- high efficiency dewatering techniques to minimise drying energy
- minimisation of water use and closed circulating water system;
- good insulation
- plant layout to reduce pumping distances
- phase optimisation of electronic control motors
- using spent cooling water (which is raised in temperature) in order to recover the heat
- use variable speed fans and fit control dampers to fume extraction ducting to balance the volume of air extracted when process units, which are connected to the system, are not in operation

Sector specific techniques

- Sintering: sensible heat from the exhaust gas of the cooler can potentially be used in boilers, to preheat combustion air or to preheat the 'green' feed. (BREF PI.2)
- Making best use of COG and BF gas in process furnaces, a gas turbine and/or CHP schemes. (BREF PI.3)
- If the blast furnace operates with high top pressure, a turbine generator (top gas expander) should be used to recover energy as the gas depressurises
- Hot blast stoves are normally fired with enriched BF gas and the energy consumption should be optimised by using fuel/air preheating, efficient burners, computer control and rapid oxygen measurement to control combustion conditions; (most modern stoves are completely computer-controlled). (BREF PI.4)

Introduction			Techniques for pollution control			Emissions			Impact		
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for further energy-efficiency requirements (Sheet 2 of 3) Climate Change Agreement for Trading Agreement.

- Reducing agents such as pulverised or granulated coal and, less frequently, oil or natural gas are commonly injected into the blast furnace as a part replacement for the more expensive coke. The resulting reduction in the consumption of coke reduces the overall pollution and energy demand of the steel works. (Coal injection can lead to increased dust content of the BF off-gas. The endothermic decomposition of these injectants has to be compensated in the furnace by either higher hot blast temperatures or oxygen enrichment of the blast air)
- Energy can be recovered from the off-gas released from the BOS process using one of two systems: (i) combustion of BOS gas in the gas duct, with recovery of sensible heat in a waste heat boiler; or (ii) suppression of BOS gas combustion and storage of the off-gas generated during appropriate parts of the blowing cycle for subsequent use as a fuel. (Recovery of BOS gas using suppressed combustion techniques usually involves lowering a skirt over the converter mouth during oxygen blowing. This prevents ambient air entering the flue gas duct, thus suppressing the combustion of carbon monoxide). The use of suppressed combustion to permit gas recovery is considered BAT. This technique not only provides a substitute for purchased fuels, it reduces the volume of exhaust gas and hence reduces the capacity of the waste gas treatment system and the energy consumed. A further benefit is that the iron fume is entrained as Fe_3O_4 rather than Fe_2O_3 and is therefore easier to recover. (BREF PI.1)
- Where practicable, lids should be placed on ladles whilst transporting hot metal around the site. This will help reduce thermal losses and minimise kish release. This is particularly important where delays may be incurred.
- reduced tap to tap time on EAF through:
 - computer control
 - ultra High Power (UHP) operation (which requires water cooled side walls and roof)
 - post combustion
 - foaming slag practice;
 - oxy-fuel burners and oxygen lancing
 - slag free tapping furnace design, such as EBT, OBT or furnace slide gate
 - ladle or secondary metallurgy
 - optimum control of the fume collection system
 - scrap pre-heating (BREF EP.2, PI.2)
- Scrap preheating on EAF using the “Shaft Furnace” or “Consteel” process. Both have constraints which depend on the range of steels being made. The former is proven and BAT for new plant, but the feasibility of retrofitting it depends on plant layout. The latter is less developed but may be more easily retrofitted. Both are applicable where only a limited range of qualities is produced. Scrap preheating may result in the creation of PCDD/F, PCBs, PAHs and other partial combustion products from scrap, which is contaminated with paint, plastics, cutting oil and lubricants. This can result from the relatively low temperatures produced in the preheated charge. However, lignite injection prior to the bag filter should provide adequate control.
- Where the product permits - use of ‘sequence casting’ (i.e. successive ladles of steel are processed by the casting machine without interruption) and ‘hot connecting’ the castor to the rolling mills. (In the case of thin slab casting, hot connecting may be via ‘direct’ connection where cast steel passes through an equalisation furnace before rolling, or in other cases, may be ‘indirect’, where warm steel is charged to a conventional reheat furnace).

Introduction			Techniques for pollution control			Emissions			Impact		
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Indicative BAT requirements for further energy-efficiency requirements (Sheet 3 of 3)
Climate Change Agreement for Trading Agreement.

Energy supply techniques

- 2 The following techniques should be considered:
 - use of Combined Heat and Power (CHP)
 - generation of energy from waste
 - use of less polluting fuels

- 3 The Operator should provide justification that the proposed or current situation represents BAT, irrespective of whether or not a CCA or DPA is in place, where there are other BAT considerations involved, eg.:
 - the choice of fuel impacts upon emissions other than carbon dioxide, eg. sulphur dioxide;
 - the potential for practical energy recovery from waste conflicts with energy efficiency requirements.

- 4 Where there is an on-site combustion plant other guidance is also relevant. For plants greater than 50MW, Operators should consult the IPC guidance on power generation (reference IPC S2 1.01 Combustion Processes: Large boilers and furnaces 50MW(th) and over and supplement IPC S3 1.01 Combustion Processes). Operators of plant of 20-50MW should consult the Local Authority Air Pollution Control guidance. On IPPC installations this guidance will be generally applicable to plant under 20MW also. (All are available from the [EA website](#)).

Introduction			Techniques for pollution control			Emissions			Impact		
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2.8 Accidents

This section covers accidents and their consequences. It is not limited to major accidents but includes spills and abnormal operation.

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). IPPC and COMAH can sometimes overlap, and some systems and information may be usable for either regime.

The COMAH regime applies to major hazards, and for accident scenarios covered by COMAH, Operators may refer in the Application to any COMAH reports already held by the Regulator. However, the accident provisions under IPPC also cover those which are below the classification threshold for major accidents under COMAH, so Operators need to consider smaller accidents and abnormal operation scenarios as well. Guidance prepared in support of the COMAH Regulations (see the [COMAH guides](#)), may also help IPPC Operators in considering ways to reduce the risks and consequences of accidents - whether or not they are covered by the COMAH regime.

General management requirements are covered in [Section 2.3](#). For accident management, there are three particular components:

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

Note: Radioactive substances are covered by the Radioactive Substances Act 1993, not IPPC

Indicative BAT requirements for accidents and abnormal operations (Sheet 1 of 3)

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

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

Identify the hazards to the environment posed by the installation. Particular areas to consider may include, but should not be limited to, the following:

 - equipment breakdown (e.g. electrical relay on power supply to steel plant, or coke oven exhausters knocked out by condensate)
 - process upsets (e.g. blast furnace bleeder opening; or blowdown causing cyanide release into water; or slopping in a BOS vessel; or by-product plant upset overwhelming a biological-based water treatment plant)
 - feeding inappropriate materials to a furnace, e.g. closed containers, radioactive materials
 - contact between molten metal or slag and water
 - transfer of substances (e.g. loading or unloading from or to vessels)
 - overfilling of vessels (e.g. in by-products plant)
 - failure of plant and/or equipment (e.g. over pressure of pipework, blocked drains)
 - failure of containment (e.g. bund and or overfilling of drainage sumps)
 - failure to contain firewater
 - 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
 - vandalism

Introduction			Techniques for pollution control			Emissions			Impact		
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Indicative BAT requirements for accidents and abnormal operations (Sheet 2 of 3)

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

B - assessment of the risks. The hazards having been identified, the process of assessing the risks should address six basic questions:

- how likely is the particular event to occur (source frequency)?
- what substances are released and how much of each (risk evaluation of the event)?
- where do the released substances end up (emission prediction - what are the pathways and receptors)?
- what are the consequences (consequence assessment – what are the effects on the receptors)?
- what are the overall risks (determination of overall risk and its significance to the environment)?
- 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 to take 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 of the activities and the relative difficulty in deciding and justifying the adequacy of the risk-control techniques

C - identification of the techniques necessary to reduce the risks. The following techniques are relevant to most installations:

- there should be an up-to-date inventory of substances, present or likely to be present, which could have environmental consequences if they escape. This should include apparently innocuous substances that can be environmentally damaging if they escape (for example, a tanker of milk spilled into a watercourse can destroy its ecosystem). The Permit will require the Regulator to be notified of any significant changes to the inventory.
- procedures should be in place for checking and handling raw materials and wastes to ensure compatibility with other substances with which they may accidentally come into contact.
- storage arrangements for raw materials, products and wastes should be designed and operated to minimise risks to the environment.
- there should be automatic process controls backed-up by manual supervision, both to minimise the frequency of emergency situations and to maintain control during emergency situations. Instrumentation will include, where appropriate, microprocessor control, trips and process interlocks, coupled with independent level, temperature, flow and pressure metering and high or low alarms.
- physical protection should be in place where appropriate (eg. barriers to prevent damage to equipment from the movement of vehicles).
- there should be appropriate secondary containment (eg. bunds, catchpots, building containment).
- techniques and procedures should be in place to prevent overfilling of tanks - liquid or powder - (eg. level measurement displayed both locally and at the central control point, independent high-level alarms, high-level cut-off, and batch metering).
- where the installation is situated in a floodplain, consideration should be given to techniques which will minimise the risk of the flooding causing a pollution incident or making one worse.
- security systems to prevent unauthorised access should be provided where appropriate.
- there should be formal systems for the logging and recording of all incidents, near-misses, abnormal events, changes to procedures and significant findings of maintenance inspections.

Introduction			Techniques for pollution control			Emissions			Impact		
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Indicative BAT requirements for accidents and abnormal operations (Sheet 3 of 3)

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

- there should be procedures for responding to and learning from incidents, near-misses, etc.
- the roles and responsibilities of personnel involved in incident management should be formally specified.
- clear guidance should be available on how each accident scenario might best be managed (eg. containment or dispersion, to extinguish fires or to let them burn).
- procedures should be in place to avoid incidents occurring as a result of poor communications between staff at shift change or during maintenance or other engineering work.
- safe shutdown procedures should be in place.
- communication channels with emergency services and other relevant authorities should be established, and available for use in the event of an incident. Procedures should include the assessment of harm following an incident and the steps needed to redress this
- appropriate control techniques should be in place to limit the consequences of an accident, such as isolation of drains, provision of oil spillage equipment, alerting of relevant authorities and evacuation procedures.
- personnel training requirements should be identified and training provided.
- the systems for the prevention of fugitive emissions are generally relevant ([Section 2.2.4](#) and [Section 2.2.5](#)) 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 with a sensor and automatic pump to storage (not to discharge);
 - there should be a system in place to ensure that sump levels are kept to a minimum at all times;
 - high-level alarms and similar back-up instruments should not be used as the primary method of level control.
- duplicate or standby plant should be provided where necessary, with maintenance and testing to the same standards as the main plant;
- spill contingency procedures should be in place to minimise accidental release of raw materials, products and waste materials and then to prevent their entry into water.
- process waters, potentially contaminated site drainage waters, emergency firewater, chemically-contaminated waters and spillages of chemicals should be contained and, where necessary, routed to the effluent system and treated before emission to controlled waters or sewer. Sufficient storage should be provided to ensure that this can be achieved. Any emergency firewater collection system should take account of the additional firewater flows and fire-fighting foams, and emergency storage lagoons may be needed to prevent contaminated firewater reaching controlled waters (see the [Releases to water references](#)).
- consideration should be given to the possibility of containment or abatement of 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.

Introduction		Techniques for pollution control			Emissions			Impact			
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2.9 Noise

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

Where noise issues are likely to be relevant, the Operator will be required, in the Application, to provide information on the following: (for more details see [H3 Part 1 Noise](#))

- the main sources of noise and vibration that will fall within the IPPC installation and also on Infrequent sources of noise and vibration
- the nearest noise-sensitive sites
- conditions/limits imposed under other regimes
- the local noise environment
- any environmental noise measurement surveys, modelling or any other noise measurements
- any specific local issues and proposals for improvements.

The level of detail supplied should be in keeping with the risk of causing noise-related annoyance at sensitive receptors.

Where an installation poses no risk of noise-related environmental impact because the activities undertaken are inherently quiet, this should be justified and no further information relating to noise need normally be supplied. It should, however, be remembered that there can still be an underlying level of annoyance without complaints being made.

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

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

For advice on how noise and/or vibration related limits and conditions will be determined see [H3 Part 1 Noise](#)

Indicative BAT requirements for noise and vibration (Sheet 1 of 2)

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

- 1 The Operator should employ basic good practice measures for the control of noise, including adequate maintenance of any parts of plant or equipment whose deterioration may give rise to increases in noise (for example, bearings, air handling plant, the building fabric, and specific noise attenuation kit associated with plant or machinery).
- 2 The Operator should employ such other noise control techniques necessary to ensure that the noise from the installation does not give rise to reasonable cause for annoyance, in the view of the Regulator. In particular, the Operator should justify where Rating Levels ($L_{Aeq,T}$) from the installation exceed the numerical value of the Background Sound Level ($L_{A90,T}$).

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Indicative BAT requirements for noise and vibration (Sheet 2 of 2)

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

- 3 Further justification will be required should the resulting field rating level ($L_{AR,TR}$) exceed 50 dB by day and a facade rating level exceed 45 dB by night, with day being defined as 07:00 to 23:00 and night 23:00 to 07:00.
- 4 In some circumstances "creeping background" (i.e. creeping ambient) may be an issue. Where this has been identified in pre-application discussions or in previous discussions with the local authority, the Operator should employ such noise control techniques as are considered appropriate to minimise problems to an acceptable level within the BAT criteria.
- 5 Noise surveys, measurements, investigations (e.g. on sound power levels of individual items of plant) or modelling may be necessary for either new or for existing installations, depending upon the potential for noise problems. Where appropriate, the Operator should have a noise management plan as part of its management system.
- 6 **Raw materials handling**
 - minimise height from which scrap is dropped
 - where possible and necessary, use berms to screen scrap preparation areas
 - where necessary in noise sensitive areas, discontinue scrap preparation during the silent hours
 - select mobile plant to give minimal noise emission (where necessary)
- 7 **Sintering**
 - sinter cooler and deduster equipment to meet appropriate noise standards
- 8 **Coke making**
 - select fans and mobile plant to give minimal noise emission (where necessary)
- 9 **Blast furnace iron making**
 - blower to have appropriate noise attenuation; and
 - unplanned circumstances requiring venting through bleeder valves to be identified and controls introduced to minimise risk. Review sequence in which the valves open to see if impacts can be reduced. Bleeder openings on high pressure blast furnaces can be a major cause of noise complaints. (*BREF Section 9.2.2.5*)
- 10 **BOS steel making**
 - suitable noise attenuation measures if oxygen blowing causes noise at boundary fence
 - select fans with minimal noise emission (where necessary)
- 11 **Electric arc steel making**
 - noise attenuation on furnace doghouse, and building if necessary
 - select fans with minimal noise emission (where necessary)
- 12 **Slag handling**
 - avoid steam explosions by careful use of cooling water sprays and preventing uncontrolled water ingress into slag pits. Steam explosions can be a major cause of noise and vibration complaints
- 13 **Sensitive receptors**
 - If sensitive receptors are close to a steel plant then screening with banks should be considered.

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2.10 Monitoring

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

2.10.1 Emissions monitoring

Indicative BAT requirements for emissions monitoring (Sheet 1 of 2)

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

- 1 Monitoring should generally be undertaken during all phases of operation (i.e. commissioning, start-up, normal operation and shutting-down) unless the Regulator agrees that it is inappropriate.
- 2 Continuous monitoring and recording (or at least sampling in the case of water) are likely to be required under the following circumstances:
 - Where the potential environmental impact is significant or the concentration of 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, or sampling BOD from an effluent treatment plant.
 - Where other control measures are required to achieve satisfactory levels of emission (e.g. material selection).
- 3 Where effective surrogates are available, they may be used with the agreement of the Regulator (and without prejudice to legal requirements) to minimise monitoring costs.
- 4 Where monitoring shows that substances are not emitted in significant quantities, it may be reasonable to reduce the monitoring frequency.
- 5 Monitoring of process effluents released to controlled water and sewers should include at least the parameters in [Table 2.12](#)
- 6 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.
- 7 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.

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Indicative BAT requirements for emissions monitoring (Sheet 2 of 2)

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

8 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 14](#)) 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

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.

10 There are a wide variety of possible releases to air in this sector. The Operator should identify the substances which will be released from each, and quantify them, to enable the Regulator to determine which will require regular monitoring. Although dependent upon the individual plant, the environmental significance of the released substances and the presence of sensitive receptors, monitoring is most likely to be needed for the parameters in [Table 2.13](#):

Monitoring and reporting of emissions to water and sewer

11 An analysis covering a broad spectrum of substances should be carried out to establish that all relevant substances have been taken into account for the purpose of setting emission limits. It should cover the substances listed in Schedule 5 of the Regulations unless it is agreed with the Regulator that they are not applicable. The need to repeat such tests will depend upon the variability in the process and, for example, the variability of raw materials.

12 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.

13 In some sectors there may be releases of substances that are more difficult to measure and whose capacity for harm is uncertain, particularly when combined with other substances. "Whole effluent toxicity" monitoring techniques can therefore be appropriate to provide direct measurements of harm, for example, direct toxicity assessment. (See [Section 2.2.2](#).)

Monitoring and reporting of waste emissions

14 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

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Monitoring BREF document in preparation

Table 2.12: Monitoring of emissions to water and sewer

Parameter	Monitoring frequency		
	Integrated works (see also coke works)	EAF works	Coke works
Flow rate	Continuous and integrated daily flow rate		
pH	Continuous		
Turbidity	Continuous		
Oil & grease	Continuous		
soluble total	Flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages		
Total ammonia as N	-		Continuous
COD	flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages		
Total nitrates	-		flow weighted sample or composite samples, weekly analysis, reported as flow weighted monthly averages
BOD	-		
Monohydric phenols, cyanide (free & total)	-		
Benzene	-		
Total sulphides	flow weighted sample or composite samples, quarterly analysis, reported as flow weighted quarterly averages		-
Fe, Ni, Hg, Cr, Zn, Pb, As, Cu, Cd			-
Suspended solids	flow weighted monthly averages		

TOC, dissolved oxygen and/or DTA may be required to protect some controlled waters.

Cyanide should be monitored at hourly intervals during blast furnace blowdown.

Temperature should be monitored continuously for discharges to inland waters.

If a water treatment process is under-performing, appropriate additional short term monitoring should be introduced.

Table 2.13: Monitoring of emissions to air

Sources/Substances	Frequency
All significant solids handling, drying, crushing & abatement stacks Particulates	Once per year
Sinter main stack Particulates, sulphur dioxide & oxides of nitrogen PCDD/F I-TEQ PCB & PAH	Continuous & once per year Once per 6 months As appropriate ⁴
Sinter dedust stack Particulates	Continuous & once per year

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Table 2.13: Monitoring of emissions to air

Coke oven battery chimney Opacity Particulates Hydrogen Sulphide Oxides of Sulphur Oxides of nitrogen	Continuous Once per year Continuous Once per 3 months Once per 3 months
Coke oven batteries – quick assessments Battery top fume Duration of charging emissions Ram & Coke- side door leakage (% fuming) Coke pushing emission	Continuous observation Exception reporting assessment of all charges Twice per shift Exception reporting assessment of all pushes
Coke oven batteries – BCRA assessments TLCF & DLCF MEF & PEF	All ovens assessed once per week Random 20% of pushes each week but ensuring all ovens assessed over a 3 month period
Coke oven – coke pushing abatement Particulates passing IHRA (eg Minister Stein) system Collection performance of draught hoods	Continuous & once per year Once per year
Blast furnace stove stack Particulates Sulphur dioxide Oxides of nitrogen	Once per year Once per year Once per year
Blast furnace cast house fume abatement Opacity Particulates	Continuous ¹ Once per year
BOS converter stack Particulates	Once per year ²
BOS secondary fume extraction Particulates	Once per year
BF, BOS & EAF buildings Fugitive fume released	Continuous observation ³ & annual estimate of release
EAF melting shop fume extraction Particulates CO NO _x , SO ₂ , PCDD/F, VOC, metals PAH, PCB	Continuous ¹ & once per year Continuous for post combustion control Each once per year Once in first year & as appropriate ⁴
Iron & Steel desulphurisation stack Particulates, SO ₂ , metals	Once per year
Vacuum degasser stack Metals	Once per year
All fume abatement plant & vents Particulates	Once per year

Notes:

1. Extraction technique developed at Stocksbridge for pressure baghouses. Uses a duct running along the length of the ridge vent to collect a representative sample of gas discharge. A triboelectric probe continuously monitors the dust concentration. Sample stream can also be used to measure metals and PCDD/F. Other techniques may be necessary for other designs of baghouse.
2. Trials of triboelectric probe undertaken at Corus Llanwern late 2000.

Introduction			Techniques for pollution control			Emissions			Impact		
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3. By CCTV. Operators to undertake internal exception reporting of significant releases. Video record kept for internal investigation of complaints.
4. Emissions will be feedstock and process specific. Need for monitoring will depend on results.

2.10.2 Environmental monitoring (beyond installation)

Indicative BAT requirements for environmental monitoring (beyond installation) (Sheet 1 of 2)

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

- 1 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.
- 2 Environmental monitoring may be required, for example, when:
 - there are vulnerable receptors
 - the emissions are a significant contributor to an Environmental Quality Standard (EQS) that may be at risk
 - the Operator is looking for departures from standards based on lack of effect on the environment;
 - to validate modelling work.
- 3 The need should be considered for:
 - groundwater, where it should be designed to characterise both quality and flow and take into account short- and long-term variations in both. Monitoring will need to take place both up-gradient and down-gradient of the site
 - surface water, where consideration will be needed for sampling, analysis and reporting for upstream and downstream quality of the controlled water
 - air, including odour
 - land contamination, including vegetation, and agricultural products
 - assessment of health impacts
 - noise
- 4 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 Regulation
- 5 Guidance on air quality monitoring strategies and methodologies can be found in [Monitoring Guidance](#).

Introduction			Techniques for pollution control			Emissions			Impact		
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for environmental monitoring (beyond installation) (Sheet 2 of 2)

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

6 Environmental monitoring requirements for this sector

7 **To air:** Operators to present an Air Quality Management Plan comprising the following elements:

- continuous monitoring of fugitive and point source emissions from the site as a whole, comprising:
 - CEM and/or operators observations at process units
 - CCTV across the site
- fingerprinting of substances released to facilitate management and investigation
- a protocol for assessing the risks to local sensitive receptors at the time significant changes in releases are observed
- a protocol for managing those releases
- procedures for promptly investigating complaints about air quality (including odour) or deposition
- permanent or intermittent monitoring at off-site locations close to sensitive receptors, providing data for the Management Plan, of ambient concentrations of any prescribed substances which the installation emits which may challenge an EQS. (For example, an integrated iron and steel works would likely need to continuously monitor at least PM10, SO2 and possibly CO. Coke ovens would likely need to periodically monitor benzene and PAH; and undertake olfactory investigations).

8 **To surface water:**

- daily visual monitoring for floating oil, discoloration (e.g. iron) and other visible effects at discharge points (so far as practicable)
- regular upstream and downstream water course sampling for prescribed substances Permitted for discharge, at intervals based on risk
- ecology surveys as required to establish the longer term effects on the aqueous environment. These are usually ongoing exercises structured to take account of both the sensitive receptors in the local environment and the changes which occur naturally in that environment in terms of growth, reproduction, etc of populations of organisms as well as the general health of the water course in terms of eutrophication, weed growth, sewage fungus formation, etc.

9 **To groundwater:** Groundwater sampling may be needed where:

- there is uncertainty about drainage systems, especially on older sites
- there are deliberate discharges to groundwater
- there are any other deposits to land (common in this sector)

10 **To land:** Monitoring surveys will need to be established where sensitive soil systems or terrestrial ecosystems are at risk from indirect emission via the air. Operators of steel plants should provide a survey of PCDD/F levels in soil around the site and proposals for future monitoring.

11 **Noise:** See Section 2.9 and Ref. 20 – Noise Regulation, Measurement and Control.

Introduction			Techniques for pollution control			Emissions			Impact		
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2.10.3 Monitoring of process variables

Note: Radioactive substances are covered by the Radioactive Substances Act 1993, not IPPC

Indicative BAT requirements for monitoring of process variables (Sheet 1 of 2)

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

- 1 Some process variables may affect the environment and these should be identified and monitored as appropriate. Examples might be:

Raw materials handling:

- Monitoring for contaminants including - chloride on iron ore; sulphur in coal and oils; radioactive substances and oil (which might contain PCBs) on scrap metal (see Section 2.4.1).

Sintering:

- oil content of “revert” materials
- strand stoppages - duration and cause

Coke ovens:

- use of backup coal charging car
- use of backup coke guide car if unabated
- sticker ovens
- breakdown and availability of gas turbine, where used
- bleeder use – duration, whether ignited and cause

Blast furnaces:

- twin casting, if cast house fume abatement is sized for single tapping, with reason for each occurrence
- ponding of iron, with reason for each
- bleeder use, with explanation and investigation of root cause (as appropriate)
- availability and percentage of slag granulated
- any high metal content skulls sent for landfill (because too big for metal recovery), with cause

BOS:

- slopping and near-slopping incidents
- high iron ore additions (above a particular level) because a high proportion tends to be emitted
- explosions, with cause
- any high metal content skulls despatched for metal recovery, with cause

EAF:

- explosions, with cause

Slag handling & metal recovery:

- metal recovered from slags (by slag type) as an indication of the effectiveness of control of the slagging process
- appropriate slag pot management records
- water usage
- steam explosions

Waste:

- a breakdown of waste sent to landfill

Flaring & venting:

- quantity and quality of gas flared or vented, with reason

Introduction			Techniques for pollution control			Emissions			Impact		
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Indicative BAT requirements for monitoring of process variables (Sheet 2 of 2)

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

Regulation of environmental parameters on a throughput specific basis

- 2 Use of natural resources and emissions from an installation in this sector will vary according to production level. Some heavy metals are not degraded after release into the environment. Releases to water tend to be diluted by rainfall or, conceivably, to ensure compliance. Hence, it will be necessary for Operators to report certain parameters on a throughput specific basis to allow comparison with benchmarks in Section 3, comparisons across the sector and, in some cases, facilitate emission limits to be set. [Table 2.14](#) below is a guide to environmental performance parameters which are likely to be required as quarterly reports (where applicable). Precise reporting requirements and methodology would be agreed to best utilise existing internal management information.

Table 2.14: Environmental parameters on a throughput basis

Inputs	
Iron ore	t/t LS
Limestone	t/t LS
Dolomite	t/t LS
Scrap	t/t LS
Energy (by type)	J/t LS (t of coke at coke works)
Water (by source)	m ³ /t LS
Recycled	
Reverts to sinter plants (by type)	t/t LS
Outputs	
Coke	t
Liquid steel	t
To air:	
particulate	t/t LS (or t of coke)
SO ₂	t/t LS (or t of coke)
NO _x	t/t LS (or t of coke)
To water:	
volume (by release point)	m ³ /t LS
COD	g/t LS
suspended solids	g/t LS
oil & grease	t/t LS
total cyanide	t/t LS
phenols	t/t LS
ammonia	t/t LS
metals (Fe, Ni, Hg, Cr, Zn, Pb, As, Cu, Cd)	t/t LS
To Land:	

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In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

Table 2.14: Environmental parameters on a throughput basis

slag (by type)	t/t LS
BOS slurry	t/t LS
BF slurry	t/t LS
millscale sludge	t/t LS
refractories	t/t LS
others	t/t LS

2.10.4 Monitoring standards (Standard Reference Methods)

The Environment Agency's Monitoring Certification Scheme (MCERTS) - Background

For England and Wales, the Environment Agency has established its Monitoring Certification Scheme (MCERTS) to deliver quality environmental measurements. MCERTS provides for the product certification of monitoring systems (for example, instruments, analysers and equipment), the competency certification of personnel and the accreditation of laboratories under the requirements of European and International standards. MCERTS has been developed to reflect the growing requirements for regulatory monitoring to meet European and International standards. It brings together relevant standards into a scheme that can be easily accessed by key stakeholders, such as manufacturers, operators, regulators and test houses. Eventually, MCERTS will be extended to include all regulatory monitoring activities. Technical Guidance Notes M1 and M2 are key reference documents underpinning MCERTS for stack-emission monitoring.

The Agency has published MCERTS performance standards for continuous emissions monitoring systems (CEMs), ambient air quality monitoring systems (CAMs), the chemical testing of soils, water monitoring instrumentation and manual stack emissions monitoring. Other MCERTS standards are under development to cover portable emissions monitoring equipment, data acquisition and operators' own arrangements, such as installation, calibration and maintenance of monitoring equipment.

In Scotland, certification to the MCERTS performance standard is not required but operators will have to demonstrate that all monitoring is carried out in accordance with relevant CEN standards where they exist, and the technical requirements for monitoring specified in this guidance note. Organisations undertaking manual stack emission monitoring (and any subsequent analysis of samples) must be accredited by UKAS to ISO/IEC 17025.

The legal context of MCERTS

Some European Directives, such as the WID, specify that monitoring and related activities such as calibration must be performed to CEN standards or, if CEN standards are not available, to ISO, national or other international standards which provide data of a suitable quality. As MCERTS is based on international standards - primarily CEN standards - MCERTS is a means of demonstrating compliance with applicable standards. Furthermore, MCERTS for CEMs provides test data to demonstrate that the monitoring equipment meets the uncertainty specifications specified in, for example, Annex III of the WID, and therefore demonstrates compliance with the QAL1 requirements of a new standard, EN14181 as described in section 2.10.5.

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MCERTS for CEMs

There are three elements to MCERTS for CEMs, which are:

- performance specifications for CEMs, drawn from international standards such as BS EN 12619 for total organic carbon (TOC);
- performance evaluation of CEMs, based on international standards including specific standards for CEMs (such as BS EN 12619), and test standards such as ISO 9169 and BS EN ISO/IEC 17025;
- product certification based on BS EN 45011.

Product certification assures that the manufacturing of CEMs is reproducible and that manufacturers take into account the impact of design changes to CEMs, assuring that any such changes to certified equipment do not degrade the performance below the MCERTS performance standards.

When selecting CEMs for plant, the certified range and determinands are important. For example, the CEMs for incinerators should have MCERTS certification for the determinands specified in the WID, as well as peripheral determinands such as oxygen and moisture if the CEMs measure emissions on a wet basis.

Regarding certified ranges, the range should not be greater than 1.5x the daily average ELV. For example, Table 2.10 below shows some examples of daily average emission limit values for key determinands and the applicable certified ranges. One exception to this rule is for hydrogen fluoride measurements, where the ELV is 1 mg/m³. In the case of HF, certified ranges up to 5 mg/m³ are acceptable. Certified ranges may be smaller than those based on a 1.5x multiplier of the ELV, since it has been demonstrated that CEMs proven over low ranges typically perform more than acceptably over high ranges. However, the converse is not necessarily true.

Table 2.15: Some applicable certified MCERTS ranges for incineration

Determinand	Daily average ELV (mg/m ³)	Applicable minimum certified range (mg/m ³)
Nitrogen oxides (as NO ₂)	200	300
Sulphur dioxide (SO ₂)	50	75
Carbon monoxide (CO)	50	75
Total dust	10	15
Hydrogen chloride (HCl)	10	15
Total organic carbon (TOC)	10	15

MCERTS and the German type-approval scheme

Germany operates a type-approval scheme for CEMs, whereby the testing is typically performed by TÜV laboratories and the approval is issued by the German Federal Environment Agency, the Umweltbundesamt (UBA). As there are similarities between MCERTS and the UBA schemes, UBA and the Agency cooperated in 2002 to align their respective schemes so that future testing and certification could provide for mutual recognition.

This mutual recognition also means that there is a fast-track scheme for equipment approved in one country and requiring certification in the other. The fast-track scheme means reduced performance evaluations due to mutual recognition of previous testing and certification. This has meant that some CEMs type-approved in Germany have been through the fast-track process and are now MCERTS certified as well.

CEN is currently developing an international standard for the performance evaluation and certification of CEMs. This standard is based on the aligned Anglo-German scheme.

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MCERTS for manual stack monitoring

MCERTS for manual stack-emission monitoring is split into two components - the certification of personnel and the accreditation of organisations. MCERTS requires stack-emission monitoring organisations to be accredited by the United Kingdom Accreditation Service (UKAS) to ISO/IEC 17025 and the MCERTS performance standard for organisations. It provides an application of EN ISO/IEC 17025 in the specific field of measurement of air emissions from stacks and covers:

- ethical requirements for independence and environmental awareness;
- use of MCERTS certified personnel;
- selection of appropriate methods following international standards;
- method implementation;
- estimation of measurement uncertainty;
- use of appropriate equipment;
- planning of a sampling measurement campaign including provisions for a site review, risk assessment and a site-specific protocol;
- reporting of results;
- participation in proficiency-testing schemes.

The standard does not provide a sectorial application for analytical laboratory methods but does specify that any methods shall be accredited to the requirements of EN ISO/IEC 17025.

The MCERTS personnel competency standard defines the standards for certifying stack-emission monitoring personnel as competent based on experience, training and examination. The standard provides for two levels of personal competency, defined as L1 and L2. The first level, L1, covers the main requirements for all personnel wishing to demonstrate competence in stack emissions monitoring whilst the second level, L2, defines further requirements for managing emissions monitoring campaigns. There are also supplementary endorsements for each level, known as Technical Endorsements (TEs). There are currently five TEs in operation while a sixth is being developed to cover calibration requirements, as specified within EN 14181. The five current TEs are:

- TE1 - Particulate monitoring by isokinetic sampling techniques
- TE2 - Multi-phase sampling techniques
- TE3 - Gases/vapours by manual techniques
- TE4 - Gases/vapours by instrumental techniques
- TE5 - Particle-size fractionation by isokinetic sampling techniques

Monitoring personnel can be certified at either L1 or L2 whether or not they work within an MCERTS accredited organisation, although the latter must have MCERTS certified personnel at both the L1 and L2 levels. In order to comply with the requirements of EN 14181, all organisations performing SRMs on incinerators must be MCERTS accredited.

MCERTS and PPC applications for permits

The following should be described in the application, indicating which monitoring provisions comply with MCERTS requirements or where 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

Introduction			Techniques for pollution control			Emissions			Impact		
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- the accreditation held by samplers and laboratories or details of the people used and the training/competencies

2.10.5 Quality assurance for CEMs

During 2004, CEN will publish a new standard entitled “EN 14181, Quality assurance of automated measuring systems (AMS)”. Shortly afterwards, the UK will adopt this standard as BS EN 14181, after which it must be used for all applicable installations. This standard will apply where EU Directives require it - for example, it will apply to all incineration and co-incineration installations which are within the scope of the WID. The scope of EN 14181 is restricted to quality assurance (QA) of the AMS, and does not include QA of the data collection and recording system of the plant.

The standard describes the procedures needed to assure that an AMS (known as CEMs in the UK) is capable of meeting the uncertainty requirements on measured values given by legislation - e.g. EU Directives or national legislation. EN 14181 defines three different quality assurance levels known as QAL 1, QAL 2 and QAL 3, plus an annual surveillance test (AST). The requirements of each of these are as follows:

QAL 1 - Uncertainty of the AMS before installation

- QAL 1 defines the procedures to demonstrate that an AMS will meet the uncertainty requirements specified in applicable EU Directives before the AMS is installed in the installation. For example, the WID specifies the uncertainty requirements in Annex III. The uncertainty of the AMS is determined using the procedures specified in another related standard, “BS EN ISO 14956, Air quality - Evaluation of the suitability of a measurement procedure by comparison with a required measurement uncertainty.” This standard makes use of performance test data produced during type-testing, i.e. MCERTS test data.

QAL 2 - Quality assurance of installation

- QAL 2 describes a procedure to calibrate the AMS and determine the variability of the measured values obtained by an SRM (with a known uncertainty) which is suitable for the validation of an AMS following its installation. The SRM, in order to comply with the requirements of EU Directives such as Annex III of the WID, must be a CEN standard or, if there is no CEN standard available, an ISO, national or other international standard capable of providing data of an equivalent quality.
- The test organisation which performs the SRM must be accredited to BS EN ISO/IEC 17025 and the appropriate SRM standards, or recognised by the Regulator. In England and Wales, the Environment Agency is using MCERTS for manual stack monitoring as a means of recognition of competence.
- During QAL 2, the test organisation must take at least 15 concurrent measurements of the SRM and AMS spread over at least 3 days, with suitable intervals between each measurement. The data is then used to determine a regression line and calibration function, followed by a variability test to determine if the uncertainty of the AMS still complies with relevant Directive requirements following installation.
- If the AMS does not meet the uncertainty requirements specified in the relevant Directive, the operator must then take corrective action to remedy this. The Directive may require the QAL 2 test to be performed at defined times - For example, the WID requires the test to be performed every three years and after major services or other major changes. The latter includes changes of fuel: for example, if the calibration function was determined for a cement kiln burning a mixture of coal and secondary liquid fuel (SLF), a new calibration may be required if a new material (e.g. tyres) were used instead of the SLF.

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- QAL 2 also defines a number of functional tests.

QAL 3 - Quality assurance during operation

- The QAL 3 procedure defines the necessary steps to demonstrate the required quality of the measurements during the normal operation of an AMS, by checking that the precision and zero and span characteristics are consistent with those determined during QAL 1.

Annual surveillance test (AST)

- The AST is a reduced QAL 2 test. The AST is designed to assure that the AMS continues to function correctly, that its performance remains valid and that the calibration function and variability remain as previously determined. In order to verify the calibration function, a qualified test organisation performs at least five repetitions of an SRM. If the calibration function is no longer valid, then a full QAL 2 test must be performed. The table below outlines the tests and checks required during the QAL 2 and AST procedures.

Table 2.16: Summary of QAL 2 and AST requirements

Activity	QAL 2		AST	
	Extractive AMS	Non-extractive AMS	Extractive AMS	Non-extractive AMS
Alignment and cleanliness		X		X
Sampling system	X		X	
Documentation and records	X	X	X	X
Serviceability	X	X	X	X
Leak test	X		X	
Zero and span check	X	X	X	X
Linearity			X	X
Interferences			X	X
Zero and span drift (Audit)			X	X
Response time	X	X	X	X
Report	X	X	X	X

Indicative BAT requirements for monitoring standards (Standard Reference Methods) (Sheet 1 of 2)

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

- 1 As far as possible, Operators should ensure their monitoring arrangements comply with the requirements of MCERTS where available, for example using certified instruments and equipment, and using a stack testing organisation accredited to MCERTS standards. Where the monitoring arrangements are not in accordance with MCERTS requirements, the Operator should provide justification and describe the monitoring provisions in detail. See www.mcerts.net for future information on MCERTS and a listing of MCERTS equipment.

Sampling and analysis standards

- 2 Standards should be selected in the order of priority as given in the IPPC Bureau's Reference Document on the General Principles of Monitoring. This order is:
 - Comitee Europeen de Normalisation (CEN)
 - International Standardisation Organisation (ISO)

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Indicative BAT requirements for monitoring standards (Standard Reference Methods) (Sheet 2 of 2)

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

If the substance cannot be monitored using CEN or ISO standards then a method can be selected from any one of the following

- American Society for Testing and Materials (ASTM)
- Association Francaise de Normalisation (AFNOR)
- British Standards Institution (BSI)
- Deutsches Institute fur Normung (DIN)
- United States Environmental Protection Agency (US EPA)
- Verein Deustcher Ingenieure (VDI)

If the substance cannot be monitored using any of the standards above then other methods may be adapted for use, following the requirements for validation in ISO 17025. For stack emission monitoring the following occupational methods may be adapted:

- Methods for the Determination of Hazardous Substances (MHDS) series published by the Health and Safety Executive (HSE)
- National Institute for Occupational Safety and Health (NIOSH)
- Occupational Safety and Health Administration (OSHA)

The intended application of the standard method must always be taken into account. For example, a CEN method may be less suitable than another less-rigorously validated standard method if the application is not one for which the CEN method was developed.

Operators should be expected to be able to demonstrate compliance with the above hierarchy and validate use of non-standard methods, in-house designed/developed methods, standard methods used outside their intended scope and modifications of standard methods to confirm that these methods are fit for purpose.

- 3 Further guidance on standards for monitoring gaseous releases relevant to IPC/IPPC is given in the [Monitoring Guidance](#). A series of updated Guidance Notes covering this subject is being prepared. This guidance specifies manual methods of sampling and analysis that will also be suitable for calibration of continuous emission monitoring instruments. Further guidance relevant to water and waste is available from the publications of the Standing Committee of Analysts.
- 4 If in doubt the Operator should consult the Regulator.

Introduction		Techniques for pollution control			Emissions			Impact			
In-process controls	Emissions controls	Management	Raw materials	Waste handling	Waste recovery or disposal	Energy	Accidents	Noise	Monitoring	Closure	Installation issues

2.11 Closure

The PPC Regulations require an Applicant to submit a site report, describing the condition of the site, as part of the application. Guidance on this is in Annex C of the Guide for Applicants (see [IPPC Part A\(1\) Installations: Guide for Applicants \(England and Wales\)](#)) or Guidance for SEPA Staff On Land and Groundwater Considerations for PPC Part A Installations (Scotland) (see [PPC Part A Installations: Guide for Applicants \(Scotland\)](#)).

Indicative BAT requirements for closure (Sheet 1 of 2)

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).

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.

2 Steps to be taken at the design-and-build stage of the activities

Care should be taken at the design stage to minimise risks during decommissioning. For existing installations, where potential problems are identified, a programme of improvements should be put in place to a timescale agreed with the Regulator. Designs should ensure that:

- underground tanks and pipework are avoided where possible (unless protected by secondary containment or a suitable monitoring programme)
- there is provision for the draining and clean-out of vessels and pipework prior to dismantling
- lagoons and landfills are designed with a view to their eventual clean-up or surrender
- insulation is provided that is readily dismantled without dust or hazard
- materials used are recyclable (having regard for operational or other environmental objectives)

3 The site-closure plan

A site closure plan should be maintained to demonstrate that, in its current state, the installation can be decommissioned to avoid any pollution risk and return the site of operation to a satisfactory state. The plan should be kept updated as material changes occur. Common sense should be used in the level of detail, since the circumstances at closure will affect the final plans. However, even at an early stage, the closure plan should include:

- either the removal or the flushing out of pipelines and vessels where appropriate and their complete emptying of any potentially harmful contents
- plans of all underground pipes and vessels
- the method and resource necessary for the clearing of lagoons
- the method of ensuring that any on-site landfills can meet the equivalent of surrender conditions
- the removal of asbestos or other potentially harmful materials unless agreed that it is reasonable to leave such liabilities to future owners
- methods of dismantling buildings and other structures, see [Closure references](#) which gives guidance on the protection of surface and groundwater at construction and demolition-sites

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Indicative BAT requirements for closure (Sheet 2 of 2)

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).

- 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
 - contamination of stocking and handling areas used for raw and recycled materials
 - aromatic contamination of coking works sites
 - heavy metals and oils at iron and steel processing units
 - heavy metals at slag and metal recovery operations
 - sediments in lagoons
- 4 For existing activities, the Operator should complete any detailed studies, and submit the site-closure plan as an improvement condition to a timescale to be agreed with the Regulator but in any case within the timescale given in [Section 1.1](#) (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.)

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2.12 Installation issues

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

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

Indicative BAT requirements for installation wide issues

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

- 1 The Operator should consider possibilities for minimising environmental impact to the environment as a whole, by operating together with other Permit holders. Possibilities include:
 - Communication procedures between the various Permit-holders; in particular those needed to ensure that the risk of environmental incidents is minimised.
 - Benefiting from the economies of scale to justify the installation of a CHP plant.
 - The combining of combustible wastes to justify a combined waste-to-energy/CHP plant.
 - The waste from one activity being a possible feedstock for another.
 - The treated effluent from one activity being of adequate quality to be the raw water feed for another activity.
 - The combining of effluent to justify a combined or upgraded effluent-treatment plant.
 - The avoidance of accidents from one activity that may have a detrimental knock-on effect on the neighbouring activity.
 - Land contamination from one activity affecting another – or the possibility that one Operator owns the land on which the other is situated.

Introduction			Techniques			Emission benchmarks			Impact
Emissions inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

3 Emission benchmarks

3.1 Emissions inventory

The Regulations require the Applicant to describe the nature, quantities and sources of foreseeable emissions into each medium. This will be done by completing the inventory of emission and consumption in the H1 software tool. The information required is as follows.

Provide a table of significant emissions of substances (except noise, vibration, odour and heat which are covered in their respective sections) that will result from the proposals and should include, preferably in order of significance:

- substance (where the substance is a mixture, for example, VOCs or COD, separate identification of the main constituents or inclusion of an improvement proposal to identify them)
- source, including height, location and efflux velocity
- media to which it is released
- any relevant EQS or other obligations
- benchmark
- proposed emissions normal/max expressed, as appropriate for:
 - mass/unit time
 - concentration
 - annual mass emissions
- statistical basis (average, percentile etc.)
- notes covering the Operators confidence in his ability to meet the benchmark values
- if intermittent, the appropriate frequencies
- plant loads at which the data is applicable
- whether measured or calculated (the method of calculation should be provided)

The response should clearly state whether the emissions are current emission rates or those planned following improvements, and should cover emissions under both normal and abnormal conditions for:

- point-source emissions to surface water, groundwater and sewer
- waste emissions
- point-source emissions to air
- significant fugitive emissions to all media, identifying the proportion of each substance released that is due to fugitives rather than point-source releases
- abnormal emissions from emergency relief vents, flares and the like
- indirect and direct emission of carbon dioxide associated with energy consumed or generated

Emissions of carbon dioxide associated with energy use should be broken down by energy type and, in the case of electricity, by source, for example, public supply, direct supply or on-site generation. Where energy is generated on-site, or from a direct (non-public) supplier, the Operator should specify and use the appropriate factor. Standard factors for carbon dioxide emissions are provided in the guidance note [H2 Energy efficiency for IPPC](#).

Where VOCs are released, the main chemical constituents of the emissions should be identified.

Introduction			Techniques			Emission benchmarks			Impact
Emissions inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

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

Indicative BAT requirements for emission benchmarks

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

- 1 The Operator should compare the emissions with the benchmark values given in the remainder of this Section.
- 2 Where the benchmarks are not met, the Operator should revisit the responses made in Section 2 as appropriate and make proposals for improvements or justify not doing so as part of the BAT assessment.

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emission benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

3.2 Emission benchmarks

Introduction to emission benchmarks

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

3.2.1 Emissions to air associated with the use of BAT

The emissions quoted below are daily averages based upon continuous monitoring during the period of operation. See [Section 3.2.3](#) for the standard conditions that should be applied. Care should always be taken to convert benchmark and proposed releases to the same reference conditions for comparison. To convert measured values to reference conditions, see the [Monitoring Guidance](#) for more information. The benchmarks given do not take sampling, analytical errors, or uncertainties into account. These will be considered when setting an ELV for a Permit.

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

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

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

- not more than one calendar monthly average during any rolling twelve month period shall exceed the benchmark value by more than 10%
- not more than one half hour period during any rolling 24 hour period shall exceed the benchmark value by more than 50% (for the purpose of this limit half hourly periods commence on the hour and the half hour)

Where spot tests are employed:

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

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emission benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

3.2.2 Emissions to water associated with the use of BAT

Wastewater treatment systems can maximise the removal of metals using precipitation, sedimentation and possibly filtration. The reagents used for precipitation may be hydroxide, sulphide or a combination of both, depending on the mix of metals present. It is also practicable in many cases to re-use treated water.

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

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

Where spot samples are taken:

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

3.2.3 Standards and obligations

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

EC-based EQ standards

[IPPC: A Practical Guide](#) 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 2000 No.928, Air Quality (England) Regulations 2000 gives air quality objectives to be achieved by:
 - 2005 for nitrogen dioxide
 - 2004 for SO₂ and PM₁₀
 - 2003 for CO, 1,3-butadiene and benzene
 - in two stages for lead by 2004 and 2008 respectively
- Statutory Instrument 2002 No. 3043 The Air Quality (England) (Amendment) Regulations 2002, which sets a tighter objective for CO and a longer-term objective for benzene to be achieved by 2010.

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.

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emission benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

- 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

Other standards and obligations

Those most frequently applicable to most sectors are:

- Hazardous Waste Incineration Directive
- Waste Incineration Directive.
- Solvent Emissions Directive.
- Large Combustion Plant Directive.
- Reducing Emissions of VOCs and Levels of Ground Level Ozone: a UK Strategy (published by the Department of the Environment in October 1993. It sets out how the Government expects to meet its obligations under the UNECE VOCs Protocol to reduce its emissions by 30% (based on 1988 levels) by 1999, including the reductions projected for the major industrial sectors).
- Water Quality Objectives – assigned water quality objectives to inland rivers and water courses (ref. Surface (Rivers Ecosystem) Classification).
- The UNECE convention on long-range transboundary air pollution (negotiations are now underway which could lead to a requirement further to reduce emissions of NO_x and VOCs. A requirement to further reduce SO₂ emissions from all sources has been agreed. The second Sulphur protocol (Oslo, 1994) obliges the UK to reduce SO₂ emissions by 80% (based on 1980 levels) by 2010).
- The Montreal Protocol.
- The Habitats Directive (see [Section 4.3](#)).
- Sulphur Content of Certain Liquid Fuels Directive 1999/32/EC.

3.2.4 Units for benchmarks and setting limits in permits

Releases can be expressed in terms of:

- “**concentration**” (for example mg/l or mg/m³), which is a useful day-to-day measure of the effectiveness of any abatement plant and is usually measurable and enforceable. The total flow must be measured/controlled as well
- “**specific mass release**” (for example, kg/ 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**” (for example, kg/hr, t/yr), which relates directly to environmental impact

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

When setting limits in Permits, the most appropriate measure will depend on the purpose of the limit. It may also be appropriate to use surrogate parameters, which reflect optimum environmental performance of plant as the routine measurement, supported by less frequent check-analyses on the

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emission benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

final concentration. Examples of surrogate measures would be the continuous measurement of conductivity (after ion-exchange treatment) or total carbon (before a guard-column in activated carbon treatment) to indicate when regeneration or replacement is required.

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

3.2.5 Statistical basis for benchmarks and limits in permits

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

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

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

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

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & Suspended Solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

3.3 Particulate & Suspended Solids

The term particulate for releases to air includes all particle sizes from submicron fume to coarse dust from storage yards.

Other Applicable Standards and Obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements).

Statutory Instrument 2000 No 928, The Air Quality (England) Regulations and its equivalents, as amended give air quality objectives to be achieved by 2004 for PM10.

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum, February 2003, has objectives for PM10 to be achieved by 2010.

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & Suspended Solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

Benchmark Emission Values

Table 3.1: Benchmark particulate and suspended solids emission values

Media	Activity	Benchmark value				
		Basis for the Benchmark	Mass release or BCRA standard	Reference	Concn or Spot test	Reference
To air	Sinter main stack	With enhanced EP Bag filter	-		<50 mg/m ³ daily average <20 mg/m ³ daily average	BREF Executive Summary ⁴
	Sinter cooler	With enhanced EP			<50 mg/m ³ daily average	
	Coke making - charging	Smokeless or Sequential with double ascension pipes or jumper pipe	MEF unnecessary at BAT. MEF ave ¹ < 0.35 (all <0.7) - until upgrade.	UK experience	< 10 sec's on dry coal < 30 sec's on wet coal	BREF Sec. 6.3
	- main doors	Well maintained; flexible seals	DLCF ave ¹ > 99%		<5% of doors fuming (new plant) <10% fuming (existing plant) <5% fuming	BREF Sec. 6.4
	- levelling doors - lids	Sealing package	TLCF ave ¹ >99%		<1% fuming	
	- ascension pipes	Luted			<1% fuming	
	- pushing	Well maintained				
	- quenching	IHRA (Minister Stein with bag filter)	<5 g/t coke	BREF Sec. 6.4	< 10 mg/m ³ on bag filter PEF ave ¹ <0.2 (all <0.7) - until upgrade.	UK experience
	Battery chimney	Well maintained old plant	Up to 3,700 g/t coke		<50 mg/m ³ monthly average (old plant) <25 mg/m ³ monthly average (new plant)	S2 1.06 UK experience
					< Ringelmann 1 daily average	UK experience
	Ammonia incinerator Flare	-	-	-	50 mg/m ³ monthly average	S2 1.06
					Smoke free	UK experience
	BF stoves		3-6 g/t pig iron	BREF Sec. 7.2.2.1.1	< 10 mg/m ³ spot sample	BREF Sec. 7.2.2.1.1
	BF slag granulation				20 mg/m ³	S2 2.01
	BOS Blow start & end Suppressed combustion Full combustion	Venturi scrubber	1 g/t LS 180 g/t LS	BREF 8.2.2 BREF 8.2.2	115 mg/m ³ 5-15 mg/m ³ 25-100 mg/m ³	UK exp'nce BREF 8.2.2 BREF 8.2.2

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & Suspended Solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

Table 3.1: Benchmark particulate and suspended solids emission values

Media	Activity	Benchmark value				
		Basis for the Benchmark	Mass release or BCRA standard	Reference	Conc'n or Spot test	Reference
To Air	BF cast house	Fume abatement with bag filter	2-85 g/t pig iron	BREF Table 7.2	New plant: <10 mg/m ³ hourly average	BREF Sec. 7.4
	Hot metal treatments & transfers. All secondary fume abatement		<5 g/t LS			BREF Sec. 8.4
	EAF primary fume EAF secondary fume EAF combined extraction		20 g/t LS ²	BREF Table 9.1 Note 4		Existing plant: <15 mg/m ³ (daily means) <10 mg/m ³ 95%ile of hourly averages per day
	Scarfig & oxygas cutting	Wet EP			50 mg/m ³	
Water (Suspended solids)	Coke works	Settling in clarifier or tertiary cleanup			40 mg/l @ DWF ³	UK experience
	Integrated Coke, Iron & Steel				40 mg/l @ DWF ³	
	EAF				40 mg/l @ DWF ³	

1: MEF & PEF as a 13 week rolling average of a pre-planned survey. Random selection of ovens - so far as possible given constraints, e.g. daylight. Ovens to be assessed at the rate of 20% of daily production surveyed per week. TLCF and DLCF is a weekly average.

2: This fume extraction plant tends to operate with very high dilution so g/t LS provides a useful basis for comparisons between plants.

3: DWF is dry weather flow, where dry weather is defined as less than 0.5 mm of rainfall occurring in any rolling 24 hour period including the time of sampling. A higher site-specific limit may be set for wet weather. The BREF suggests water emissions of 0.4 m³/t coke produced and 0.2 m³/t hot metal (blast furnace) but gives no benchmarks for steel making.

4: The BREF is not clear on the averaging period basis. The agency has taken a preliminary view.

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

3.4 Sulphur

Other Applicable Standards and Obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements).

Statutory Instrument 2000 No 928, The Air Quality (England) Regulations, and its equivalent in Wales, Statutory Instrument 2000 No 1940 (W.138), The Air Quality (Wales) Regulations, give air quality objectives to be achieved by 2004 and 2005 for sulphur dioxide.

The UNECE convention on long-range transboundary air pollution. Under this Convention, a requirement further to reduce SO₂ emissions from all sources has been agreed. The second Sulphur Protocol (Oslo, 1994) obliges the UK to reduce SO₂ emissions by 80% (based on 1980 levels) by 2010.

Sulphur in Liquid Fuels Regulations. From 1 January 2003, the sulphur content of heavy fuel oil must not exceed 1% except (Article 3) if the SO₂ emissions are less than or equal to 1700 mg/m³ (3% O₂, dry). Sulphur levels in gas oil must not exceed 0.2% from 1 July 2000, and 0.1% from 1 January 2008. See Regulations and Large Combustion Installations Directive for requirements for large combustion plant.

Benchmark Emission Values

Table 3.2: Benchmark sulphur emission values

Media	Substance	Activity	Benchmark value				
			Basis for the Benchmark	Mass release	Reference	Conc'n	Reference
To air	Sulphur dioxide	Sintering	S content of inputs	800-2000 g/t sinter	BREF Sec. 4.2.2.1.2.5	< 500 mg/m ³ spot sample	BREF Sec. 4.4
			FGD			< 100 mg SO ₂ /m ³	
		Coke battery chimney	Desulphurised COG (By absorption: 500-1000 mg H ₂ S/m ³ . By oxidation: <500 mg H ₂ S/m ³ (BREF Sec 6.4))	80-300 g/t coke	Table 6.3	200 mg/m ³ monthly avg.	S2 1.06
		Ammonia incinerator	-	-	-	200 mg/m ³	S2 1.06
		BF stoves	Varies with S content of gas fired	16-400 g/t pig iron	Table 7.2	25 mg/m ³ LV spot sample	UK experience
		BF slag granulation	with fume condensation	1-151 g/t pig iron	Table 7.2	100 mg/m ³ LV spot sample	UK experience
	Hydrogen sulphide				100 mg/m ³	S2 1.06	
	Sulphur dioxide	BF cast house		2-266 g/t pig iron	Table 7.2	-	-
	EAF	1 German plant	24-130 g/t LS	Table 9.1			
To water	Sulphide	Coke works				<0.1 mg/l @ DWF	BREF Sec. 6.4

DWF: Dry weather flow rate

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxides	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

3.5 Nitrogen oxides

Other Applicable Standards and Obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements).

Statutory Instrument 2000 No 928, The Air Quality (England) Regulations, and its equivalents, as amended, give air quality objectives to be achieved by 2005 for nitrogen dioxide.

The UNECE convention on long-range transboundary air pollution. Negotiations are now underway which could lead to a requirement further to reduce emissions of NO_x.

Waste Incineration Directive sets an ELV for NO_x.

Benchmark Emission Values

Table 3.3: Benchmark nitrogen oxides emission values

Media	Activity	Benchmark value				
		Basis for the Benchmark	Mass release	Reference	Conc'n	Reference
To air	Sintering	N content of inputs & waste gas recirculation	400-650 g NO _x /t sinter	BREF Sec. 4.2.2.1.2.7	200-310 mg NO _x /m ³ spot sample	BREF Sec. 4.2.2.1.2.7
	Coke battery chimney	Lean firing, staged combustion	450-700 g NO _x /t coke	BREF Sec 6.4	275 mg NO _x /m ³ monthly average	S2 1.06
		Rich firing, staged combustion			<350 mg NO _x /m ³ spot sample	UK experience
		Lean firing			<1300 mg NO _x /m ³ spot sample	
	Ammonia incinerator	Rich firing			<1300 mg NO _x /m ³ spot sample	UK Experience
		-	-	-	<120 mg NO _x /m ³ spot sample	
	BF stoves		10-580 g/t pig iron	Sec. 7.2.2.1.1	< 350 mg/m ³ (@ 3% O ₂)	BREF Sec. 7.4
	EAF		120-240 g/t	BREF Table 9.1	<50 mg/m ³	UK experience

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

3.6 Oxides of carbon

Other Applicable Standards and Obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements).

Statutory Instrument 2000 No 928, The Air Quality (England) Regulations and its equivalents, as amended, give air quality objectives to be achieved by 2003 for carbon monoxide.

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum, February 2003, has objectives for PM10 to be achieved by 2003.

National Climate Change commitments:

- UK to cut emissions of specific greenhouse gases by 12.5% from 1990 to 2008-2012, as part of EU commitment under Kyoto Agreement.
- UK has a national target to cut CO₂ emissions by 20% from 1990 to 2010 (equivalent to 2.5M tC/year by 2010).

Benchmark Emission Values

Table 3.4: Benchmark oxides of carbon emission values

Media	Substance	Activity	Basis for the Benchmark	Benchmark	Reference
To air	CO	Sinter main stack		12-39 kg CO/t sinter	BREF Table 4.1
		Coke works	New-old (>20y)	0.39-4.5 kg CO/t coke	BREF Table 6.2
		Blast furnace		0.77-1.75 kg/t LS	BREF Table 7.1
		BOS plant		1.5-8.0 kg/t LS	BREF Table 8.2
		EAF plant		0.74-3.9 kg/t LS	BREF Table 9.1
				200 mg/m ³ maximum 100 mg/m ³ hourly average	UK experience
	CO ₂	Sinter main stack		190-220 kg CO ₂ /t sinter	BREF Table 4.1
		Coke works		520 kg CO ₂ /t coke	BREF Table 6.2
		Blast furnace		280-500 kg/t LS	BREF Table 7.1
		BOS plant	Partial-full combustion	11.2-140kg/t LS	BREF Table 8.2

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

3.7 Organic substances

3.7.1 Polychlorinated Dibenzo-p-dioxins and Furans (PCDD/F)

Other Applicable Standards and Obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements).

Hazardous Waste Incineration Directive and Waste Incineration Directive have requirements concerning PCDD/F.

Benchmark Emission Values

Table 3.5: Benchmark polychlorinated dibenzo-p-dioxins and furans (PCDD/F) emission values

Media	Activity	Benchmark value				
		Basis for the Benchmark	Mass release	Reference	Conc'n	Reference
To air	Sinter main stack	Control of strand & inputs (Cl & oil) + fabric filter & lignite injection	1-10 µg I-TEQ/t sinter	BREF Sec. 4.2.2.1.2.9	0.1-0.5 ng I-TEQ/m ³ spot determination	BREF Sec. 4.4
	EAF stack	Post combustion + rapid quench and/or lignite injection before bag filter	0.07-9 µg I-TEQ/t LS	Sec. 9.2.2.1.1	0.1-0.5 ng I-TEQ/m ³	BREF Sec. 9.4

3.7.2 Other organic substances

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).

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.

The UNECE convention on long range transboundary air pollution. Negotiations are now underway which could lead to a requirement further to reduce emissions of VOCs.

Statutory Instrument 2000 No 928, The Air Quality (England) Regulations and its equivalents, as amended, give air quality objectives to be achieved by 2003 and 2010 for benzene.

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum, February 2003, has objectives for benzene and PAH to be achieved by 2010.

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

Dangerous Substances Directive 76/464/EEC sets requirements for List I substances (including persistent oils and hydrocarbons; and substances with carcinogenic properties) and List II substances (including non persistent mineral oils and hydrocarbons and inorganic compounds of phosphorus).

Benchmark Emission Values

Table 3.6: Benchmark other organic substances emission values

Media	Substance	Activity	Basis for the Benchmark	Benchmark	Reference
To air	Volatile Organic Compounds (VOC)	Sinter main stack		140 g/t sinter	BREF Table 4.1
		Coke works	Excludes CH ₄	12-24 g/t coke	BREF Table 6.2
		EAF		20 mg/m ³ hourly average (expressed as carbon)	UK experience
	Polycyclic Aromatic hydrocarbons (PAH)	Sinter main stack		105-840 mg Σ EPA16/ t sinter	BREF Sec. 4.2.2.1.2.12
		Coke works		500-1500 mg Σ EPA16/ t coke	BREF Table 6.2
		EAF works		3.5-71 mg Σ EPA16/ t LS	BREF Table 9.1
	Polychlorinated Biphenyls (PCB)	Sinter main stack	Control of strand & inputs	1-12 mg Σ PCB/t sinter	BREF Sec. 4.2.2.1.2.10
		EAF stack	Control of inputs	15-45 mg Σ PCB/t LS	BREF Sec. 9.2.2.1.1
		Chlorobenzenes	EAF main stack	1-37 mg/t LS	BREF Sec. 9.2.2.1.1
To water	Monohydric phenol	Coke works	Biological (Nitrification/denitrification) & physico-chemical treatment	<0.5 mg/l @ DWF	BREF Sec. 6.4 & UK coke works
		Integrated coke, iron & steel		<0.5 mg/l @ DWF (assumes can meet BREF coke standards)	
	PAH (6 Borneff)	Coke works		<0.05 mg/l	
	Total oil & grease	Coke works		3 mg/l @ DWF	
		Integrated coke, iron & steel works		3 mg/l @ DWF	
		EAF works		Oil separation	

DWF is Dry Weather Flow Rate, i.e. measured after 24 hours of less than 0.5 mm total rainfall and after optimisation of water treatment to maximise recycling. This is likely to be installation specific. The BREF suggests 0.4 m³/t coke produced and 0.1 m³/t hot metal (blast furnace) but gives no benchmarks for steel making.

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory emission limits

3.8 Inorganic substances

Other Applicable Standards and Obligations

Dangerous Substances Directive 76/464/EEC sets requirements for List II substances (including cyanides, fluorides, ammonia and nitrites).

Benchmark Emission Values

Table 3.7: Benchmark inorganic substances emission values

Media	Substance	Activity	Basis for the Benchmark	Benchmark	Reference
To water	COD	Coke works	Activated sludge and physico-chemical treatment (nitrification/denitrification)	300 mg/l @ DWF	UK experience BREF Sec. 6.4 BREF Sec. 6.4
		Integrated coke, iron & steel works		300 mg/l @ DWF	
	Ammoniacal N	Coke works		5 mg N/l @ DWF	
		Integrated coke, iron & steel		5 mg N/l @ DWF	
	Total cyanide	Coke works		<0.1 mg N/l @ DWF	
		Integrated coke, iron & steel		0.5 mg/l @ DWF	
	Total NH ₄ ⁺ , NO ₃ ⁻ & NO ₂ ⁻	Coke works		<30 mg N / l @ DWF	
	Thiocyanate			1 mg/l @ DWF	

DWF is Dry Weather Flow Rate, i.e. after 24 hours with less than 0.5 mm rainfall and optimisation of water treatment to maximise recycling. This is likely to be installation specific. The BREF suggests 0.4 m³/t coke produced and 0.1 m³/t hot metal (blast furnace) but gives no benchmarks for steel making.

3.9 Heavy Metals

Other Applicable Standards and Obligations

(Extracts from standards are quoted for ease of reference. The relevant standards should be consulted for the definitive requirements).

Statutory Instrument 2000 No 928, The Air Quality (England) Regulations, and its equivalents, as amended, give air quality objectives for lead to be achieved in two stages by 2004 and 2008 respectively.

Table 3.8: Dangerous substances

	Zinc and Copper	Mercury	Cadmium
	g (as metal)/l annual average		
Designated freshwaters SI 1997/1331 UK Water Quality Objectives	Depends on water hardness – see regulations and Note 1		
Dangerous Substances List 1 Fresh: Coastal:		1.0 0.3	5 2.5
Dangerous Substances List 2 (Fresh or tidal)	Most metals – see Note 1		

Note 1: Unless these metals are known to be present – further monitoring or ELV are not normally required.

Benchmark Emission Values

Note: Heavy metal emissions will vary according to the type of steel produced. Well maintained existing bag filters may emit about twice the particulate level as new plant (i.e. 40 g/t LS compared with <20 g/t LS for new). Heavy metal emissions are likely to correspond to particulate emissions. Data available on metals releases is limited. BREF data is only an approximate guide.

Table 3.9: Benchmark heavy metals and other substances emission values

Media	Substance	Activity	Benchmark	Reference	Basis for the Benchmark
To air	Cadmium	Sinter main stack	0.002 g/t sinter	BREF Table 4.1	Bag filter
			0.1 mg/m ³ hourly average	S2 2.01	
		BOS	0.07 g/t LS	BREF Table 8.5	Suppressed combustion
			1 mg/m ³ hourly average	S2 2.01	
		EAF stacks	<0.01 g/t LS	UK Experience	Existing bag filter. Carbon and high alloy steels
			0.2 mg/m ³ hourly average	S2 2.01	
To water		Integrated works	0.05 mg/l @ DWF	S2 2.01	
		EAF works	0.05 mg/l @ DWF		

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy Metals	Mandatory emission limits

Table 3.9: Benchmark heavy metals and other substances emission values

Media	Substance	Activity	Benchmark	Reference	Basis for the Benchmark
To air	Chromium	Sinter main stack	0.005 g/t sinter	BREF Table 4.1	Bag filter
		BOS	0.01 g/t LS	BREF Table 8.2	Effective secondary fume collection
		EAF stacks	<0.38-3.8 g/t LS	UK experience	Existing bag filter. Carbon to high alloy steels
		Stainless & special alloys	2 mg/m ³ hourly average	S2 2.01	
			4 mg/m ³ hourly average		
To water	Chromium	Integrated works	0.2 mg/l @ DWF	S2 2.01	
		EAF works	0.2 mg/l @ DWF		High alloy steels will be higher
To air	Copper	Sinter main stack	0.006 g/t sinter	BREF Table 4.1	Bag filter
		BOS	0.01 g/t LS	BREF Table 8.2	Effective secondary fume collection
		EAF stacks	<0.34 g/t LS	UK experience	Existing bag filter. Carbon steel.
To water	Copper	Integrated works	0.5 mg/l @ DWF	S2 2.01	
		EAF works	0.5 mg/l @ DWF		
To air	Mercury	Sinter main stack	0.015 g/t sinter	BREF Table 4.1	Bag filter
		EAF stacks	<0.04-0.08 g/t LS	UK experience	Existing bag filter. Carbon to high alloy steels
To water	Mercury	EAF works	0.02 mg/l @ DWF	S2 2.01	
To air	Manganese	Sinter main stack	0.018 g/t sinter	BREF Table 4.1	Bag filter
		BOS	<0.01 g/t LS	BREF Table 8.2	Effective secondary fume collection
To air	Nickel	Sinter main stack	0.002 g/t sinter	BREF Table 4.1	Bag filter
		EAF stacks	0.08-1.2 g/t LS	UK experience	Existing bag filter. Carbon to high alloy steel
			1 mg/m ³ hourly average	S2 2.01	
Stainless & special alloys	2 mg/m ³ hourly average				
To water	Nickel	Integrated works	Background		
		EAF works	0.5 mg/l @ DWF	S2 2.01	

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy Metals	Mandatory emission limits

Table 3.9: Benchmark heavy metals and other substances emission values

Media	Substance	Activity	Benchmark	Reference	Basis for the Benchmark
To air	Lead	Sinter main stack	0.04 g/t sinter	BREF Table 4.1	Bag filter
			2 mg/m ³ hourly average	S2 2.01	
		BOS	0.13 g/t LS	BREF Table 8.2	Effective secondary fume collection
			1 mg/m ³ hourly average	S2 2.01	
		Leaded steel	3 mg/m ³ hourly average	S2 2.01	Existing bag filter
		EAF stacks	2.4 g/t LS	UK experience	
		(carbon steel)	1 mg/m ³ hourly average	S2 2.01	
		To water		Integrated works	0.2 mg/l @ DWF
EAF works	0.2 mg/l @ DWF				
To air	Thallium	Sinter main stack	0.005 g/t sinter	BREF Table 4.1	Bag filter
To air	Vanadium	Sinter main stack	0.005 g/t sinter	BREF Table 4.1	Bag filter
To air	Zinc	Sinter main stack	0.002 g/t sinter	BREF Table 4.1	Bag filter
		EAF stacks	8.5 g/t LS	UK experience	Bag filter
To water		Integrated works	0.5 mg/l @ DWF	S2 2.01	
		EAF works	0.5 mg/l @ DWF		
To air	Iron	BOS stack	2.8 g/t LS	BREF Table 8.5	Suppressed combustion
To water		Integrated works	5 mg/l @ DWF	S2 2.01	
		EAF works	5 mg/l @ DWF		
To air	Hydrogen fluoride	Sinter main stack	1.3 g/t sinter	BREF Table 4.1	
	Fluorides	EAF stacks	5 mg/m ³ hourly average	S2 2.01	Bag filter

DWF is Dry Weather Flow Rate, i.e. after 24 hours with less than 0.5 mm of rainfall and after optimisation of water treatment to maximise recycling. This is likely to be installation specific. The BREF suggests 0.4 m³/t coke produced and 0.1 m³/t hot metal (blast furnace) but gives no benchmarks for steel making.

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory Emission Limits

3.10 Mandatory Emission Limits

The Hazardous Waste Incineration Directive (HWID) and Waste Incineration Directive (WID) make requirements on furnaces if they incinerate waste. These include ELVs (to air and water) and requirements on design, operation and continuous emission monitoring.

Where Operators are considering the burning of any waste, or waste derived fuel, in their installation it is essential that they should contact the Agency to discuss whether the incineration directives will apply.

3.10.1 Hazardous Waste Incineration Directive

The HWID was implemented in the UK by a combination of Secretary of State Direction and Regulations (SI1998 No.767). The standards required by HWID required compliance from 1 July 2000. A Regulatory Guidance Note (issued 14 July 1999) provides detailed guidance for Environment Agency officers.

The Directive applies not only to dedicated hazardous waste incinerators but also to the burning of hazardous waste in plants not intended primarily for that purpose, such as a blast or steel furnace. The Directive requires that if more than 40% of the heat input to a furnace is supplied by fuel classified as hazardous waste under Article 2(1), then the full requirements of the Directive must be applied. Other requirements are made if the heat obtained from burning hazardous waste is 40% or less of the total furnace heat input. If any amount of hazardous waste is burned the Directive may apply. Note that definition of hazardous waste is drawn from the hazardous waste list. This has been revised (ref: 2000/532/EC), which may have the effect of extending the scope of the HWID. Further amendments to the list are planned to take effect by 1 January 2002.

3.10.2 Waste Incineration Directive

The Waste Incineration Directive was published on 28 December 2000 (2000/76/EC). It has been developed to fill the gaps between existing Directives on municipal waste incineration and hazardous waste incineration. WID may apply wherever hazardous or non-hazardous waste is burned either in dedicated incineration plant or in “co-incineration plant” whose primary purpose is the production of energy or of material products. The existing Directives will be replaced by the Waste Incineration Directive. The Environment Agency intends to issue guidance when detailed implementation arrangements are known.

In summary, the implementation timetable is:

- New plant: shall comply with this Directive no later than 2 years after its entry into force i.e. by 28 December 2002.
- Existing plant: shall comply with this Directive no later than 5 years after its entry into force i.e. by 28 December 2005.

Introduction			Techniques			Emission benchmarks			Impact
Emissions Inventory	Emissions benchmarks	Particulate & suspended solids	Sulphur	Nitrogen oxide	Oxides of carbon	Organic substances	Inorganic substances	Heavy metals	Mandatory Emission Limits

Co-incineration' plants which start co-incinerating waste not later than four years after the Directive comes into force (i.e. before 28 December 2004), are to be regarded as existing co-incineration plants. They will therefore not need to comply with the standards of the Directive until 28 December 2005 (unless these standards are already considered to be BAT).

As with HWID, WID contains provisions for the co-incineration of hazardous wastes in which the 40% thermal substitution rule applies, although it should be emphasised that the Directive will apply when any amount of waste is co-incinerated.

The WID also goes beyond emission limit values. Permits will be required to include an extensive range of conditions to ensure high operational standards.

4 Impact

4.1 Impact assessment

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 EQS etc, revisiting the techniques in Section 2 as necessary. The use of **IPPC Environmental Assessments for BAT**, and the IPPC Environmental Assessments for BAT software tool, and the other tools on the Application CD, will lead the Applicant through the process.

The depth to which the impact assessment should go should be discussed with the Regulator. For some low risk sites the requirements may be reduced.

Indicative BAT requirements for impact assessment (Sheet 1 of 2)

Provide an assessment of the potential significant environmental effects (including trans-boundary effects) of the foreseeable emissions.

- 1 Provide a description, including maps as appropriate, of the receiving environment to identify the receptors of pollution. The extent of the area may cover the local, national and international (for example, transboundary effects) environment as appropriate.
- 2 Identify important receptors, which may include: areas of human population including noise or odour-sensitive areas, flora and fauna (that is, Habitat Directive sites, special areas of conservation, Sites of Special Scientific Interest (SSSI or in Northern Ireland ASSI) or other sensitive areas), soil, water, that is groundwater (water below the surface of the ground in the saturation zone and in direct contact with the ground and subsoil) and watercourses (for example, ditches, streams, brooks, rivers), air, including the upper atmosphere, landscape, material assets and the cultural heritage.
- 3 Identify the pathways by which the receptors will be exposed (where not self-evident).
- 4 Carry out an assessment of the potential impact of the total emissions from the activities on these receptors. **IPPC Environmental Assessments for BAT** 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**) with:
 - community EQS levels
 - other statutory obligations
 - non-statutory obligations
 - environmental action levels (EALs) and the other environmental and regulatory parameters defined in **IPPC Environmental Assessments for BAT**
- 5 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.

Indicative BAT requirements for impact assessment (Sheet 2 of 2)

Provide an assessment of the potential significant environmental effects (including trans-boundary effects) of the foreseeable emissions.

- 6 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.
- 7 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.
- 8 Where the same pollutants are being emitted by more than one permitted activity on the installation, the Operator should assess the impact both with and without the neighbouring emissions.

4.2 Waste Management Licensing Regulations

Indicative BAT requirements for waste management licensing regulations

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.

- 1 In relation to activities involving the disposal or recovery of waste, the Regulators are required to exercise their functions for the purpose of achieving the relevant objectives as set out in Schedule 4 of the Waste Management Licensing Regulations 1994. (For the equivalent Regulations in Scotland and Northern Ireland, see [Appendix 2](#).)
- 2 The relevant objectives, contained in paragraph 4, Schedule 4 of the Waste Management Licensing Regulations 1994 (SI 1994/1056 as amended) are extensive, but will only require attention for activities that involve the recovery or disposal of waste. Paragraph 4 (1) is as follows:
 - 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
 - implementing, as far as material, any plan made under the plan-making provisions
- 3 The application of BAT is likely to already address risks to water, air, soil, plants or animals, odour nuisance and some aspects of effects on the countryside. It will, however, be necessary for the Operator briefly to consider each of these objectives individually and provide a comment on how they are being addressed by your proposals. It is also necessary to ensure that any places of special concern that could be affected, such as SSSIs, are identified and commented upon although, again, these may have been addressed in your assessment for BAT, in which case a cross-reference may suffice.
- 4 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

Indicative BAT requirements for the habitats regulations

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 purpose of the Conservation (Natural Habitats etc.) Regulations 1994 (SI 1994/2716)

- 1 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.
- 2 European sites are defined in Regulation 10 of the Habitats Regulations to include Special Areas of Conservation (SACs); sites of community importance (sites that have been selected as candidate SACs by member states and adopted by the European Commission, but which are not yet formally classified); and Special Protection Areas (SPAs). It is also Government policy (set out in PPG 9 on nature conservation) that potential SPAs and candidate SACs should be considered to be European sites for the purposes of Regulation 10.
- 3 Information on the location of European sites and their conservation objectives is available from:
 - English Nature (01733 455000), www.english-nature.org.uk
 - Countryside Council for Wales (01248 385620), www.ccw.gov.uk
 - Scottish Natural Heritage (0131 447 4784), www.snh.org.uk
 - Joint Nature Conservation Committee (01733 866852), www.jncc.gov.uk
 - Environment and Heritage Service, Northern Ireland (02890254754), www.ehsni.gov.uk
- 4 The Regulator will need to consider the Operator's initial assessment. If it concludes that the installation is likely to have a significant effect on a European site, then the Regulator will need to carry out an "appropriate assessment" of the implications of the installation in view of that site's conservation objectives. The Regulations impose a duty on the Regulator to carry out these assessments, so it cannot rely on the Operator's initial assessments. Therefore the Regulator must be provided with any relevant information upon which the Operator's assessment is based.
- 5 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 Website <http://www.environment-agency.gov.uk>. Many of the references below are being made available free of charge for viewing or download on the Website. The same information can also be accessed via the SEPA web site <http://www.sepa.org.uk>, or the NIEHS web site www.ehsni.gov.uk. Most titles will also be available in hard copy from The Stationery Office (TSO). Some existing titles are not yet available on the Website but can be obtained from TSO.

- Ref 1 *IPPC Reference Document on Best Available Techniques in the Steel Industry* European Commission <http://eippcb.jrc.es>
- Ref 2 *The Pollution Prevention and Control Act (1999)* (www.hms.gov.uk).
- Ref 3 *The Pollution Prevention and Control Regulations* (SI 2000 No. 1973) (www.hms.gov.uk).
- Ref 4 *IPPC: A Practical Guide* (for England and Wales) (or equivalents in Scotland and Northern Ireland) www.defra.gov.uk/environment/ppc/ippcguide/index.htm
- Ref 5 Guidance for applicants
- *IPPC Part A(1) Installations: Guide for (Applicants England and Wales)* (includes Preparation of a Site Report in a Permit Application) ([EA website](http://www.environment-agency.gov.uk)).
 - *PPC Part A Installations: Guide for Applicants (Scotland)* (Guidance for SEPA staff on land and groundwater considerations) [Guidance for SEPA staff on land and groundwater considerations](http://www.environment-agency.gov.uk)
 - *IPPC Regulatory Guidance Series No.5 - Interpretation of "Installation" in the PPC Regulations* www.environment-agency.gov.uk
- Ref 6 Assessment methodologies:
- *E1 BPEO Assessment Methodology for IPC*
 - *IPPC Environmental Assessments for BAT H1*
- Ref 7 Waste minimisation support references
- *Environment Agency web site*. Waste minimisation information accessible via: www.environment-agency.gov.uk/subjects/waste/131528
 - *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 Envirowise and the BOC Foundation (a software tool designed for small and medium businesses.). Available free from The Environmental Helpline (tel: 0800 585794)
 - *ENVIROWISE*. A joint DTI/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.gov.uk
 - *Increased Profit Through Improved Materials Additions: Management/Technical Guide*, ENVIROWISE, 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 on-line searching and on CD-ROM. Short enquiries are free (tel: 01235 463162)
 - *Waste Minimisation – Institution of Chemical Engineers Training Package E07*. Basic course which contains guide, video, slides, OHPs etc. (tel: 01788 578214)
 - *BIO-WISE - profiting through industrial biotechnology*. A DTI programme providing free advice and information about how biotechnology can be used within manufacturing industry. Case studies, guides website and Helpline 0800 432100. dti.gov.uk/biowise (leather guide GG237 and case study 11)
- Ref 8 Water efficiency references:
- *Simple measures restrict water costs*, ENVIROWISE, GC22
 - *Effluent costs eliminated by water treatment*, ENVIROWISE, GC24
 - *Saving money through waste minimisation: Reducing water use*, ENVIROWISE, GG26
 - *ENVIROWISE Helpline* 0800 585794

- *Optimum use of water for industry and agriculture dependent on direct abstraction: Best practice manual.* R&D technical report W157, Environment Agency (1998), WRc Dissemination Centre, Swindon (tel: 01793 865012)
 - *Cost-effective Water Saving Devices and Practices* ENVIROWISE GG067
 - *Water and Cost Savings from Improved Process Control* ENVIROWISE GC110
 - *Tracking Water Use to Cut Costs* ENVIROWISE GG152
- Ref 9 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, 0-11-752925-7
 - A3 Pollution abatement technology for particulate and trace gas removal, 1994, £5.00, 0-11-752983-4
 - 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)
- Ref 10 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 website](#))
 - *Pollution Prevention Guidance Note – Above-ground oil storage tanks*, PPG 2, Environment Agency, gives information on tanks and bunding which have general relevance beyond just oil ([EA website](#))
 - *Construction of bunds for oil storage tanks*, Mason, P. A, Amies, H. J, Sangarapillai, G. Rose, 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 on-line purchase)
 - *Policy and Practice for the Protection of Groundwater* (PPPG) ([EA website](#))
 - *Choosing Cost-effective Pollution Control* ENVIROWISE GG109
 - *Cost-effective Separation Technologies for Minimising Wastes and Effluents* ENVIROWISE GG037
 - *Cost-effective Membrane Technologies for Minimising: Wastes and Effluents* ENVIROWISE GG044
- Ref 11 Waste management references
- *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
- Ref 12 Energy references
- *(Interim) Energy Efficiency Guidance*, (available as draft Horizontal Guidance Note IPPC H2) (www.environment-agency.gov.uk)
- Ref 13 COMAH guides
- *A Guide to the Control of Major Accident Hazards Regulations 1999*, Health and Safety Executive (HSE) Books L111, 1999, ISBN 0 07176 1604 5
 - *Preparing Safety Reports: Control of Major Accident Hazards Regulations 1999*, HSE Books HS(G)190, 1999
 - *Emergency Planning for Major Accidents: Control of Major Accident Hazards Regulations 1999*, HSE Books HS(G)191, 1999
 - *Guidance on the Environmental Risk Assessment Aspects of COMAH Safety Reports*, Environment Agency, 1999 ([EA website](#))
 - *Guidance on the Interpretation of Major Accidents to the Environment for the Purposes of the COMAH Regulations*, DEFRA, 1999, ISBN 753501 X, available from the Stationery Office
- Ref 14 Monitoring Guidance
- *MCERTS approved equipment* link via www.mcerts.net
 - *Technical Guidance Note M1 - Sampling requirements for monitoring stack emissions to air from industrial installations*, Version 2, Environment Agency, 2002. www.environment-agency.gov.uk
 - *Technical Guidance Note M2 - Monitoring of stack emissions to air*, Version 2, Environment Agency, 2003. www.environment-agency.gov.uk
 - *Technical Guidance Note M18 - Monitoring of discharges to water*, Version 1, Environment Agency,, 2004. www.environment-agency.gov.uk
 - *Direct Toxicity Assessment for Effluent Control* Technical Guidance (2000), UKWIR 00/TX/02/07
- Ref 15 Noise references:
- *H3 Horizontal Guidance for Noise Part 1* Regulation and Permitting
 - *H3 Horizontal Guidance for Noise Part 2* Assessment and Control

Ref 16 Closure references

- *Working at Construction and Demolition-sites* (PPG 6) ([EA website](#))

Ref 17 Air Dispersion

- *Guidelines on Discharge Stack Heights for Polluting Emissions*, HMIP Technical Guidance Note (Dispersion) D1, 1993, ISBN 0-11-752794-7 www.tso.co.uk/bookshop; (or www.environment-agency.gov.uk for summary only)

Ref 18 Fire Fighting

- *BS 5908: Code of Practice for Fire Precautions in the Chemical and Allied Industries*
- *PPG 18 - Managing Fire-water and major spillages*, Environment Agency Pollution Prevention Guidance Note (see Ref 10)

Ref 19 Volatile Organic Compounds

- *The Categorisation of Volatile Organic Compounds*, 1995 HMIP Research Report No DOE/HMIP/RR/95/009 (www.environment-agency.gov.uk)

Abbreviations

BAT	Best Available Techniques – see IPPC A Practical Guide or the Regulations for further definition
BAT Criteria	The criteria to be taken into account when assessing BAT, given in Schedule 2 of the PPC Regulations
BOD	Biochemical Oxygen Demand
BREF	BAT Reference Document
CEM	Continuous Emissions Monitoring
CHP	Combined heat and power plant
COD	Chemical Oxygen Demand
ELV	Emission Limit Value
EMS	Environmental Management System
EQS	Environmental Quality Standard
ETP	Effluent treatment plant
FOG	Fat Oil Grease
ITEQ	International Toxicity Equivalents
MCERTS	Monitoring Certification Scheme
NIEHS	Northern Ireland Environment and Heritage Service
SAC	Special Areas of Conservation
SECp	Specific Energy consumption
SEPA	Scottish Environment Protection Agency
SPA	Special Protection Area
TSS	Suspended solids
TOC	Total Organic Carbon
VOC	Volatile organic compounds

Appendix 1: Some common monitoring and sampling methods

The Agency's Technical Guidance Notes (Monitoring) M1, Sampling Requirements for Monitoring Stack Emissions to Air from Industrial Installations, and M2, Monitoring of Stack Emissions to Air, are available via the "Search Site" facility on the Agency's web page, <http://www.environment-agency.gov.uk/>, entering M1 or M2 as the keyword. These documents provide key references as regards more detailed insight into different approaches to monitoring stack emissions, sampling strategies and choice of technique, method, and equipment. Relative advantages and disadvantages of continuous versus periodic measurements are summarised in Part 2 of M2. Situations where continuous monitoring (continuous emissions monitoring systems - CEMs) may be more appropriate are discussed further in Section 5 of this note. Manual sampling and analysis methods are used to meet periodic or intermittent regulatory monitoring requirements and in some cases for validation and calibration of CEMs.

Table 4.1: Measurement methods for common substances to water

Determinand	Method	Detection limit Uncertainty	Valid for range mg/l	Standard
Suspended solids	Filtration through glass fibre filters	1 mg/l 20%	10-40	ISO 11929:1997, EN872 - Determination of suspended solids
COD	Oxidation with di-chromate	12 mg/l 20%	50-400	ISO 6060: 1989, Water Quality - Determination of chemical oxygen demand
BOD5	Seeding with micro-organisms and measurement of oxygen content	2 mg/l 20%	5-30	ISO 5815: 1989, Water Quality Determination of BOD after 5 days, dilution and seeding method EN 1899 (BOD 2 Parts)
AOX	Adsorption on activated carbon and combustion	-- 20%	0.4 - 1.0	ISO 9562: 1998, EN1485 - Determination of adsorbable organically bound halogens.
Tot P				BS 6068: Section 2.28 1997, Determination of phosphorus – ammonium molybdate spectrometric method
Tot N				BS 6068: Section 2.62 1998, Determination of nitrogen Part 1 Method using oxidative digestion with peroxydisulphate, BS EN ISO 11905
pH				SCA The measurement of electric conductivity and the determination of pH, ISBN 0117514284
Turbidity				SCA Colour and turbidity of waters 1981, ISBN 0117519553 EN 27027:1999
Flow rate	Mechanical ultrasonic or electromagnetic gauges			SCA Estimation of Flow and Load, ISBN 011752364X
Temperature				
TOC				SCA The Instrumental Determination of Total Organic Carbon and Related Determinants 1995, ISBN 0117529796 EN 1484:1997
Fatty acids				Determination of Volatile Fatty Acids in Sewage Sludge 1979, ISBN 0117514624
Metals				BS 6068: Section 2.60 1998, Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy
Chlorine				BS6068: Section 2.27 1990, Method for the determination of total chlorine: iodometric titration method
Chloroform Bromoform				BS 6068: Section 2.58, Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods

Table 4.1: Measurement methods for common substances to water

Determinand	Method	Detection limit Uncertainty	Valid for range mg/l	Standard
Dispersants Surfactants Anionic Cationic Non-ionic				SCA Analysis of Surfactants in Waters, Wastewaters and Sludges, ISBN 01176058 EN 903:1993 (Used for anionic surfactants)
Pentachloro- Phenol				BS5666 Part 6 1983, Wood preservative and treated timber quantitative analysis of wood preservatives containing pentachlorophenol EN 12673:1997 (used for chlorophenol and polychlorinated phenols)
Formaldehyde				SCA The determination of formaldehyde, other volatile aldehydes and alcohols in water
Phosphates and nitrates				BS 6068: Section 2.53 1997, Determination of dissolved ions by liquid chromatography
Sulphites and sulphates				BS 6068: Section 2.53 1997, Determination of dissolved ions by liquid chromatography
Ammonia				BS 6068: Section 2.11 1987, Method for the determination of ammonium: automated spectrometric method
Grease and oils	IR absorption	0.06 mg/kg		SCA The determination of hydrocarbon oils in waters by solvent extraction IR absorption and gravimetry, ISBN 011751 7283

Table 4.2: Measurement methods for air emissions

Determinand	Method	Avg'ing time Detection limit Uncertainty	Compliance criterion	Standard
Formaldehyde	Impingement In 2,4 dinitro-phenyl- Hydrazine HPLC	1 hour 1 mg/m ³ 30%	Average of 3 consecutive samples below specified limit	US EPA Method 316 Method specific to formaldehyde.
Ammonia	FTIR or Ion Chromatogra- phy	1 hour 0.5mg/m ³ 25%		US EPA Method 320 for extractive instruments. US EPA Method 26 for wet chemistry.
VOCs	Speciated - Adsorption Thermal Desorption GCMS	1 hour 0.1 mg/m ³ 30%		BS EN 1076:1997 Workplace atmospheres. Pumped sorbent tubes for the determination of gases and vapours. Requirements and test methods.
	Total Organic Car- bon	1 hour 0.4 mg/m ³ calculated	Continuous or spot check	BS EN 12619:1999. Determination of the mass concentration of total gaseous organic carbon at low concentrations in flue gases – continuous flame ionisation method.3
Chloroform	Absorption on acti- vated carbon sol- vent extraction. GC analysis	1 hour 1 mg/m ³ 20%	Average of 3 consecutive samples below specified limit	MDHS 28 Chlorinated hydrocarbon solvent vapours in air (modified)
Oxides of Sulphur	UV fluorescence Automatic ana- lyser	1 hour 1 ppm 10%	95% of hourly averages over a year below specified limit	BS6069 Section 4.4 :1993 (ISO 7935) Stationary source emissions-determination of mass concentrations of sulphur dioxide4.
	Wet sampling train ion chromatogra- phy	1 hour 1 mg/m ³ 25%	Average of 3 consecutive samples below specified limit	BS6069 Section 4.1:1998 (ISO 7934) Method for the determination of the mass concentration of sulphur dioxide-hydrogen peroxide/barium perchlorate method

Table 4.2: Measurement methods for air emissions

Determinand	Method	Avg'ing time Detection limit Uncertainty	Compliance criterion	Standard
Hydrogen Chloride	Wet sampling 3 analytical methods	30 minute minimum 0.2 mg/m ³ calculated	One test	BS EN 1911:Parts 1-3:1998 Manual method of determination of HCl
Particulate matter	Extractive – sample train	3 minutes per point 5 mg/m ³ 10%	One test	BS EN 13284-1:2002 Determination of low range mass concentration of dust — Part 1: Manual gravimetric method.
	Continuous – Automatic analyser	Continuous N/A 10%	Continuous	BS ISO 10155:1995 Automated Monitoring of mass concentrations of particles – performance characteristics, test methods and specifications.
PCDD/F	Extractive – Sample train GC/MS	4 hour minimum 8 hour maximum 0.1 ng I-TEQ/m ³ calculated		BS EN 1948:1997 determination of the mass concentration of PCDD/F

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

See also [Monitoring Guidance](#)

Appendix 2: Equivalent legislation in Wales, Scotland & Northern Ireland

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

Table 4.3: Equivalent legislation

England	Wales	Scotland	Northern Ireland
PPC Regulations (England and Wales) 2000, SI 2000 No.273 (as amended)	As England	PPC (Scotland) Regulations 2000, SSI 2000 No.323 (as amended)	PPC (NI) Regulations 2003, SR 2003 No.323
SI:1994 1056: Waste Management Licensing Regulations	As England	As England	SR 2003 No. 493: The Waste Management and Licensing Regulations (NI) 2003
The Water Resources Act 1991	As England	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 1995 No. 3146: The Air Quality Standards (Amendments) Regulations 1995 SI 2002 No. 3043 The Air Quality (England) (Amendment) Regulations 2002	As England SI 2002 No. 3182 (W.298) The Air Quality (Amendment) (Wales) Regulations 2002	As England SSI 2002 No. 297 The Air Quality (Scotland) Amendment Regulations 2002	SR 1990 No.145: The Air Quality Standards Regulations (Northern Ireland) 1990 SR1996 No.23: The Air Quality Standards (Amendments) Regulations (Northern Ireland) 1996
SI 2000 No.928: The Air Quality (England) Regulations 2000 SI 2002 No. 3117 The Air Quality Limit Values (Amendment) Regulations 2002	SI 2000 No.1940 (W.138): The Air Quality (Wales) Regulations 2000 SI 2002 No. 3183 (W.299) The Air Quality Limit Values (Wales) Regulations 2002	SSI 2000/97: The Air Quality (Scotland) Regulations SSI 2002 No. 566 The Air Quality Limit Values (Scotland) Amendment Regulations 2002	No NI equivalent
SI 2001 No.2315: The Air Quality Limit Values Regulations 2001	SI 2001 No.2683 (W.224): The Air Quality Limit Values (Wales) Regulations 2001	SSI 2001 No.224: The Air Quality Limit Values (Scotland) Regulations 2001	SI 2002 No.94: The Air Quality Limit Values (Northern Ireland) Regulations 2002
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)	As England	SI 1990/126: Surface Water (Dangerous Substances) (Classification) (Scotland) Regulations	Surface Waters (Dangerous Substances) (Classification) Regulations 1998. Statutory Rules of Northern Ireland 1998 No 397
SI 1991 No.1597: Bathing Waters (Classification) Regulations 1991	As England	SI 1991 No.1609: Bathing Waters (Classification) (Scotland) Regulations 1991	The Quality of Bathing Water Regulations (NI) 1993

Table 4.3: Equivalent legislation

England	Wales	Scotland	Northern Ireland
SI 1997 No.1331: The Surface Waters (Fishlife) (Classification) Regulations 1997	As England	SI 1997 No.2471 (S.163): The Surface Waters (Fishlife) (Classification) (Scotland) Regulations 1997	The Surface Water (Fishlife) (Classification) Regulations (NI) 1997
SI 1997 No.1332: The Surface Waters (Shellfish) (Classification) Regulations 1997	As England	SI 1997 No.2470 (S.162): The Surface Waters (Shellfish) (Classification) (Scotland) Regulations 1997	The Surface Water (Shellfish) (Classification) Regulations (NI) 1997
SI 1994 No.2716: The Conservation (Natural Habitats, etc) Regulations	As England	As England	Conservation (Natural Habitats etc) Regulations (Northern Ireland) 1995
SI 1999 No.743: Control of Major Accident Hazards Regulations (COMAH) 1999	As England	As England	SR 2000 No.93: Control of Major Accident Hazards Regulations (Northern Ireland) 2000
SI 1998 No.2746: The Groundwater Regulations 1998	As England	As England	SR 1998 No.401. The Groundwater Regulations (Northern Ireland) 1998
SI 2002 No.2980: The Waste Incineration (England and Wales) Regulations 2002	As England	SSI 2003 No.170 : The Waste Incineration (Scotland) Regulations 2003	SR 2003 No.390: The Waste Incineration Regulations (Northern Ireland) 2003

Appendix 3: Groundwater Regulations 1998

Schedule of listed substances and recommendations for List I (DEFRA)

List I

- 1.-(1) Subject to the sub paragraph below, a substance is in List I if it belongs to one of the following families or groups of substances:
- (a) organohalogen compounds and substances that may form such compounds in the aquatic environment
 - (b) organotin compounds
 - (c) substances that possess carcinogenic, mutagenic or teratogenic properties in or via the aquatic environment (including substances that have those properties that would otherwise be in List II)
 - (d) mercury and its compounds
 - (e) cadmium and its compounds
 - (f) mineral oils and hydrocarbons
 - (g) cyanides.
- 1.-(2) A substance is not in List I if it has been determined by the Regulator to be inappropriate to List I on the basis of a low risk of toxicity, persistence and bioaccumulation.

List II

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

zinc	tin	copper
barium	nickel	beryllium
chromium	boron	lead
uranium	selenium	vanadium
arsenic	cobalt	antimony
thallium	molybdenum	tellurium
titanium	silver	
 - (b) biocides and their derivatives not appearing in List I
 - (c) substances that have a harmful effect on the taste or odour of groundwater, and compounds liable to cause the formation of such substances in such water and to render it unfit for human consumption
 - (d) toxic or persistent organic compounds of silicon, and substances that may cause the formation of such compounds in water, excluding those which are biologically harmless or are rapidly converted in water into harmless substances
 - (e) inorganic compounds of phosphorus and elemental phosphorus
 - (f) fluorides
 - (g) ammonia and nitrates.
- 2.-(2) A substance is also in List 2 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 inappropriate to List II having regard to toxicity, persistence and bioaccumulation.

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

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

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

List of substances recommended to be confirmed as List I

- as recommended by the Joint Agency Groundwater Directive Advisory Group.

Aldrin	Diuron
Atrazine	Endosulfan
Azinphos-ethyl	Fenitrothion
Bromoxynil (as Bromoxynil-phenol)	Fenthion
Bromoxynil octanoate	Heptachlor
Cadmium	Hexachlorobenzene
2-Chloroaniline	Hexachlorobutadiene (HCBD)
Chlorobenzene	Hexachlorocyclohexane
Chlordane	Hexachloroethane
Chloro-2,4-dinitrobenzene	Hexachloronorbomadiene
Chlorfenvinphos	Hexaconazole
4-Chloro-3-methylphenol	3-Iodo-2-propionyl n-butyl carbamate (IPBC)
Chloro-2-nitrobenzene	Linuron
Chloro-3-nitrobenzene	Malathion
Chloro-4-nitrobenzene	Mercury
2-Chlorophenol	Mevinphos
Chlorothalonil	Oxydemeton-methyl
2-Chlorotoluene	Parathion
a-Chlorotoluene	Parathion-methyl
Chlorpyrifos	Pentachlorobenzene
Coumaphos	Pentachloroethane
Cypermethrin	Pentachlorophenol (PCP)
DDT	Permethrin
Demeton	Propanil
Diazinon	Simazine
Dibutyl bis(oxyauroyl)tin	Tetrabutyltin
Dichlofluanid	1,2,4,5-Tetrachlorobenzene

Dichloroaniline	Tetrachloroethylene
1,2-Dichlorobenzene	Triazophos
1,3-Dichlorobenzene	Tributyl tin oxide (TBTO)
1,4-Dichlorobenzene	Tributyl-phosphate
Dichloronitrobenzene (all isomers)	Trichlorfon
2,4-Dichlorophenol	1,2,4-Trichlorobenzene
1,3-Dichloropropene	Trichloroethylene
Dichlorprop	Trichlorophenol (all isomers)
Dichlorvos	Trifluralin
Dicofol	Triphenyl tin oxide (TPTO)
Dieldrin	Triphenyl-phosphate
Dimethoate	